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AN APPLICATION OF DETERMINANT AND MATRIX THEORY TO THE CALCULATION OF GLASS BATCHES

By R. B. GREKILA, Chief Chemist
Ball Brothers Company, Inc., Muncie, Indiana

Abstract

This paper presents the theoretical consideration of glass batch calculations along with a general development of determinant and matrix theory. Sample problems are worked out for flint and amber in both matrices and determinants. A rough method of figuring fining agents in the calculated batch is also included.

Determinants are applied to finding the necessary proportions of raw materials for a desired analysis. Matrix theory is applied to the calculation of final glass analysis from raw materials, as well as calculating the proportions of raw materials from the glass analysis.

The presentation is general, designed to be applied by the reader to his own particular situation.

Introduction

This article is divided into three major sections: Section I deals with the theoretical considerations of glass batch calculations; Section II is devoted to two average sample calculations; Section III presents a method of including fining agents into the calculated batch.

Part I. Determinants: Before undertaking the first section, it would perhaps be best to review a few of the principles of determinants.

Let us say that a determinant is a short-cut notation implying the solution of n equations in n unknowns. Its notation is simply (in the case of 2 by 2): $\begin{vmatrix} a_1 & b_1 \\ a_2 & b_2 \end{vmatrix}$ which by definition will equal $a_1b_2 - a_2b_1$.

Operation: Again in the case of 2 by 2 determinants, let us take the two equations:

$$y^1 = a^1_1 x^1 + a^1_2 x^2$$
$$y^2 = a^2_1 x^1 + a^2_2 x^2.$$

We shall then define their solution by determinants as:

$$x^1 = \frac{\begin{vmatrix} y^1 & a^1_2 \\ y^2 & a^2_2 \end{vmatrix}}{\begin{vmatrix} a^1_1 & a^1_2 \\ a^2_1 & a^2_2 \end{vmatrix}} = \frac{D^1}{D} \text{ and } x^2 = \frac{\begin{vmatrix} a^1_1 & y^1 \\ a^2_1 & y^2 \end{vmatrix}}{\begin{vmatrix} a^1_1 & a^1_2 \\ a^2_1 & a^2_2 \end{vmatrix}} = \frac{D^2}{D}.$$

The letter D is the symbol for the determinant of the coefficients of the unknowns. It is formed by writing the coefficients of the first unknown in the first column and the coefficients of the second unknown in the same order in the second column (and so on). The symbol D^j (where $j = 1,2, \ldots, n$) is the determinant formed by substituting the y values in a column for the coefficients of x^j. Now let's take a simple case:

$$5 = 2x^1 + x^2$$
$$10 = 3x^1 + 4x^2.$$

$$x^1 = \frac{D^1}{D} = \frac{\begin{vmatrix} 5 & 1 \\ 10 & 4 \end{vmatrix}}{\begin{vmatrix} 2 & 1 \\ 3 & 4 \end{vmatrix}} = \frac{20 - 10}{8 - 3} = \frac{10}{5} = 2;$$

$$x^2 = \frac{D^2}{D} = \frac{\begin{vmatrix} 2 & 5 \\ 3 & 10 \end{vmatrix}}{D} = \frac{20 - 15}{5} = 1.$$

These results may be verified by substitutions in the original equations. It should be noted that D needs to be computed only once no matter how many unknowns. For example, n equations in n unknowns:

$$y^1 = a^1_1 x^1 + a^1_2 x^2 + \ldots + a^1_n x^n$$
$$y^2 = a^2_1 x^1 + a^2_2 x^2 + \ldots + a^2_n x^n$$
$$\cdots\cdots\cdots\cdots\cdots$$
$$y^n = a^n_1 x^1 + a^n_2 x^2 + \ldots + a^n_n x^n$$

$$x^1 = \frac{D^1}{D} = \frac{\begin{vmatrix} y^1 & a^1_2 \ldots a^1_n \\ y^2 & a^2_2 \ldots a^2_n \\ \cdots & \cdots \\ y^n & a^n_2 \ldots a^n_n \end{vmatrix}}{\begin{vmatrix} a^1_1 & a^1_2 \ldots a^1_n \\ a^2_1 & a^2_2 \ldots a^2_n \\ \cdots & \cdots \\ a^n_1 & a^n_2 \ldots a^n_n \end{vmatrix}} \text{ or, generally, } x^j = \frac{D^j}{D}.$$

One more point, and we're ready for Section I. A 3 by 3 determinant is defined as follows:

$$\begin{vmatrix} a^1_1 & a^1_2 & a^1_3 \\ a^2_1 & a^2_2 & a^2_3 \\ a^3_1 & a^3_2 & a^3_3 \end{vmatrix} = a^1_1 \begin{vmatrix} a^2_2 & a^2_3 \\ a^3_2 & a^3_3 \end{vmatrix} - a^1_2 \begin{vmatrix} a^2_1 & a^2_3 \\ a^3_1 & a^3_3 \end{vmatrix} + a^1_3 \begin{vmatrix} a^2_1 & a^2_2 \\ a^3_1 & a^3_2 \end{vmatrix}.$$

A 4 by 4 expansion is then defined as:

$$\begin{vmatrix} a^1_1 & a^1_2 & a^1_3 & a^1_4 \\ a^2_1 & a^2_2 & a^2_3 & a^2_4 \\ a^3_1 & a^3_2 & a^3_3 & a^3_4 \\ a^4_1 & a^4_2 & a^4_3 & a^4_4 \end{vmatrix} = a^1_1 \begin{vmatrix} a^2_2 & a^2_3 & a^2_4 \\ a^3_2 & a^3_3 & a^3_4 \\ a^4_2 & a^4_3 & a^4_4 \end{vmatrix} - a^1_2 \begin{vmatrix} a^2_1 & a^2_3 & a^2_4 \\ a^3_1 & a^3_3 & a^3_4 \\ a^4_1 & a^4_3 & a^4_4 \end{vmatrix}$$
$$+ a^1_3 \begin{vmatrix} a^2_1 & a^2_2 & a^2_4 \\ a^3_1 & a^3_2 & a^3_4 \\ a^4_1 & a^4_2 & a^4_4 \end{vmatrix} - a^1_4 \begin{vmatrix} a^2_1 & a^2_2 & a^2_3 \\ a^3_1 & a^3_2 & a^3_3 \\ a^4_1 & a^4_2 & a^4_3 \end{vmatrix}$$

This type of expansion is called expansion by minors, where a minor is the n — 1 by n — 1 determinant remaining after striking out the row and column containing a^i_j in a n by n determinant.

If more detail or more theory is desired, the reader is here referred to any standard text on college alegbra or theory of equations.

Part II. Matrix Theory: Given the Equations:

$$\begin{aligned} y^1 &= a^1_1 x^1 + a^1_2 x^2 + a^1_3 x^3 \dots \\ y^2 &= a^2_1 x^1 + a^2_2 x^2 + a^2_3 x^3 \dots \\ y^3 &= a^3_1 x^1 + a^3_2 x^2 + a^3_3 x^3 \dots \\ &\cdot \quad \cdot \quad \cdot \quad \cdot \\ &\cdot \quad \cdot \quad \cdot \quad \cdot \\ &\cdot \quad \cdot \quad \cdot \quad \cdot \end{aligned}$$

we then say that:

$$\begin{pmatrix} y^1 \\ y^2 \\ y^3 \\ \cdot \\ \cdot \\ \cdot \end{pmatrix} = \begin{pmatrix} a^1_1 a^1_2 a^1_3 \dots \\ a^2_1 a^2_2 a^2_3 \dots \\ a^3_1 a^3_2 a^3_3 \dots \\ \cdot \ \cdot \ \cdot \\ \cdot \ \cdot \ \cdot \\ \cdot \ \cdot \ \cdot \end{pmatrix} \begin{pmatrix} x^1 \\ x^2 \\ x^3 \\ \cdot \\ \cdot \\ \cdot \end{pmatrix}$$

which is evaluated by:

$$\begin{aligned} y^1 &= a^1_1 x^1 + a^1_2 x^2 + a^1_3 x^3 \\ &\cdot \\ &\cdot \\ &\cdot \end{aligned}$$

$$y^i = \sum_{j=1}^{n} a^i_j x^j \quad \begin{matrix} (\text{where } j = 1, 2, 3, \dots, n) \\ (\text{and } \ i = 1, 2, 3, \dots, m) \end{matrix}$$

and which we shall abbreviate as:

$$Y^i = A^i_j X^j.$$

Using the left inverse, we have:

$$(A^i_j)^{-1} Y^i = (A^i_j)^{-1} (A^i_j) X^j = I X^j$$
(where I is the unit matrix)

or simply:

$$X^j = (A^i_j)^{-1} Y^i.$$

and we must now define and evaluate $(A^i_j)^{-1}$.

Definition: $(A^i_j)^{-1} = \dfrac{(A^i_j)_{\text{adjoint}}}{|A^i_j|}$

Definition: $(A^i_j)_{\text{adjoint}}$ is the matrix formed by replacing a^i_j values with their minor determinants evaluated in the position a^j_i.

Example: $(A) = \begin{matrix} 1\,3\,2 \\ 4\,2\,1 \\ 3\,1\,2 \end{matrix}$

$$(A)_{\text{adjoint}} = \begin{pmatrix} \begin{vmatrix} 2 & 1 \\ 1 & 2 \end{vmatrix} & -\begin{vmatrix} 3 & 2 \\ 1 & 2 \end{vmatrix} & \begin{vmatrix} 3 & 2 \\ 2 & 1 \end{vmatrix} \\ -\begin{vmatrix} 4 & 1 \\ 3 & 2 \end{vmatrix} & \begin{vmatrix} 1 & 2 \\ 3 & 2 \end{vmatrix} & -\begin{vmatrix} 1 & 2 \\ 4 & 1 \end{vmatrix} \\ \begin{vmatrix} 4 & 2 \\ 3 & 1 \end{vmatrix} & -\begin{vmatrix} 1 & 3 \\ 3 & 1 \end{vmatrix} & \begin{vmatrix} 1 & 3 \\ 4 & 2 \end{vmatrix} \end{pmatrix}$$

Finally we have: $X^j = \dfrac{(A^i_j)_{\text{adjoint}}}{|A^i_j|} Y^i$

Section I. Theoretical Consideration.

It is often necessary to calculate the batch required to obtain a desired analysis, e.g., the situation arises where the glass analysis has strayed from the standard analysis and we wish to make a quick, exact correction in batch to bring the glass back to the standard. There are many ways of making the calculation. The following is one method.

Part I. Determinants. Given the percent analysis as:

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	...
Sand	99.7	0.10	0.04					
Soda						60		
Slag	37	12	0.40	41	8			
Feldspar	69	19	0.08	1.5		6	5	
B. Lime				58	42			
⋮								
⋮								

We now replace these names, formulae, and figures with symbols.

	y^1	y^2	y^3	...	.	...	y^{m-1}	y^m
x^1	a^1_1	a^1_2	a^1_3				a^{m-1}_1	a^m_1
x^2	a^1_2	a^2_2					.	a^m_2
x^3	a^1_3	.					. .	.
⋮	⋮	.					.	.
⋮	⋮	.					.	.
x^{m-1}	a^1_{m-1}	.					.	a^m_{m-1}
x^m	a^1_m	. a^2_m	.	.	.	.	a^{m-1}_m	a^m_m

Where:

x^j = batch raw material
y^i = % oxide in glass
a^i_j = per cent of raw material which is in analysis

We have then the following n equations in n unknowns:

$$\begin{aligned} y^1 &= a^1_1 x^1 + a^1_2 x^2 + a^1_3 x^3 + \dots + a^1_n x^n \\ y^2 &= a^2_1 x^1 + a^2_2 x^2 + a^2_3 x^3 + \dots + a^2_n x^n \\ &\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ &\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ &\cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ y^n &= a^n_1 x^1 + a^n_2 x^2 + a^n_3 x^3 + \dots + a^n_n x^n \end{aligned}$$

which can again be abbreviated as

$$y^i = \sum_{j=1}^{n} a^i_j x^j \qquad \begin{matrix} (j = 1, 2, 3, \dots, n) \\ (i = 1, 2, 3, \dots, m) \end{matrix}$$

Using now the material in determinants, we have:

$$x^j = \frac{D^j}{D}. \qquad \text{where } D \neq 0$$

We must choose our y and x^j quantities so that D does not equal zero. In terms of operation this means that there must exist a way of arranging either the rows or columns so that there is a complete (devoid of zeros) diagonal. This will often be done by additively grouping y^i and/or x^j values. The given x^j solution is then the unique amount of raw material necessary for a desired analysis. It is worthwhile to note that most of the a^i_j values are zero and, hence, simplify the final calculations.

Part II. Matrix Theory. Returning to the n equations in n unknowns in Sec. I, Part I, we have then:

$$y^i = \sum_{j=1}^{n} a^i{}_j\, x^j \qquad \begin{matrix}(j = 1, 2, 3, \ldots, n)\\ (i = 1, 2, 3, \ldots, m)\end{matrix}$$

which is the same as:

$$\begin{pmatrix} y^1 \\ y^2 \\ \cdot \\ \cdot \\ \cdot \end{pmatrix} = \begin{pmatrix} a^1{}_1\, a^1{}_2 \ldots a^1{}_n \\ a^2{}_1\, a^2{}_2 \ldots a^2{}_n \\ \cdot \quad \cdot \quad \cdot \quad \cdot \\ \cdot \quad \cdot \quad \cdot \quad \cdot \\ a^n{}_1\, a^n{}_2 \ldots a^n{}_n \end{pmatrix} \begin{pmatrix} x^1 \\ x^2 \\ \cdot \\ \cdot \\ x^n \end{pmatrix}$$

Substituting $Y = y^i$, $A = a^i{}_j$, $X = x^j$, we have:

$$Y = A\,X$$
or $$X = A^{-1}\,Y$$
or $$|A|\,X = A_{adjoint}\,Y. \qquad \text{(definition of inverse matrix)}$$

Since the determinant A, $|A|$, is simply a constant multiplier, of x_j, we may just as well omit it in our calculations and use only $A_{adjoint}$. We then have:

$$X = A_{adjoint}\,Y.$$

Section II. Application to example problems.

Part I. Determinants. Given the following desired or standard analysis for amber glass, find the proportions of raw materials necessary to obtain it.

$$y^1 = RO_2 = SiO_2 = 72.00\%$$
$$y^2 = R_2O_3 = Al_2O_3 + Fe_2O_3 = 3.00$$
$$y^3 = RO = CaO + MgO = 12.00$$
$$y^4 = R_2O = Na_2O + K_2O = 13.00$$

It should be noted that the y^i values have in some cases been grouped. We would also have the following amber raw materials analysis:

	Sand (x^1)	Soda (x^2)	Slag (x^3)	Limestone (x^4)
$y^1 = RO_2$	$99\ a^1{}_1$	$0\ a^1{}_2$	$40\ a^1{}_3$	$0\ a^1{}_4$
$y^2 = R_2O_3$	$1\ a^2{}_1$	$0\ a^2{}_2$	$10\ a^2{}_3$	$0\ a^2{}_4$
$y^3 = RO$	$0\ a^3{}_1$	$0\ a^3{}_2$	$50\ a^3{}_3$	$60\ a^3{}_4$
$y^4 = R_2O$	$0\ a^4{}_1$	$60\ a^4{}_2$	$0\ a^4{}_3$	$0\ a^4{}_4$

These figures have, of course, been simplified for ease of calculation. Any number of raw materials can be used as long as the same number of oxides are computed. A 4 by 4 determinant is usually easiest to compute.

Take the raw materials analysis and put it in the form of a determinant and evaluate it. Then $x^j = \dfrac{D^j}{D}$.

$$D = \begin{vmatrix} 99 & 0 & 40 & 0 \\ 1 & 0 & 10 & 0 \\ 0 & 0 & 50 & 60 \\ 0 & 60 & 0 & 0 \end{vmatrix} = 60 \begin{vmatrix} 99 & 40 & 0 \\ 1 & 10 & 0 \\ 0 & 50 & 60 \end{vmatrix} = 3600 \begin{vmatrix} 99 & 40 \\ 1 & 10 \end{vmatrix} = 3{,}420{,}000.$$

$$x^1 = \text{Sand} = \frac{\begin{vmatrix} 72 & 0 & 40 & 0 \\ 3 & 0 & 10 & 0 \\ 12 & 0 & 50 & 60 \\ 13 & 60 & 0 & 0 \end{vmatrix}}{D} = \frac{2{,}160{,}000}{3{,}420{,}000} = 0.63158$$

$$x^2 = \text{Soda} = \frac{\begin{vmatrix} 99 & 72 & 40 & 0 \\ 1 & 3 & 10 & 0 \\ 0 & 12 & 50 & 60 \\ 0 & 13 & 0 & 0 \end{vmatrix}}{D} = \frac{741{,}000}{3{,}420{,}000} = 0.21667$$

$$x^3 = \text{Slag} = \frac{\begin{vmatrix} 99 & 0 & 72 & 0 \\ 1 & 0 & 3 & 0 \\ 0 & 0 & 12 & 60 \\ 0 & 60 & 13 & 0 \end{vmatrix}}{D} = \frac{810{,}000}{3{,}420{,}000} = 0.23684$$

$$x^4 = \text{Limest} = \frac{\begin{vmatrix} 99 & 0 & 40 & 72 \\ 1 & 0 & 10 & 3 \\ 0 & 0 & 50 & 12 \\ 0 & 60 & 0 & 13 \end{vmatrix}}{D} = \frac{9{,}000}{3{,}420{,}000} = 0.0026316$$

Then if a 2000-pound sand batch is desired, simply multiply each x^j solution by 3166.7, since $\dfrac{2000}{.63158} = 3166.7$

We then have:

Sand	2000
Soda	686
Slag	750
Limestone ...	8.

Since all of the x^j values were quotients of the same divisor, we could, as with the matrices, omit the determinant D. Our results for x^j would then be:

Sand	2,160,000		2000
Soda	741,000	or divided	686
Slag	810,000	by 1080	750
Limestone ...	9,000		8.

Now let's try it again for flint glass, using the following flint raw materials analysis to yield the same analysis in the final glass.

	Sand	Soda	Feldspar	Burned Lime	Desired
RO_2	99	0	70	0	72.00%
R_2O_3	1	0	20	0	3.00
RO	0	0	0	100	12.00
R_2O	0	60	10	0	13.00

$$\text{Sand} = \begin{vmatrix} 72 & 0 & 70 & 0 \\ 3 & 0 & 20 & 0 \\ 12 & 0 & 0 & 100 \\ 13 & 60 & 10 & 0 \end{vmatrix} = 7{,}380{,}000$$

or divided by 3690

2000 lbs.

$$\text{Soda} = \begin{vmatrix} 99 & 72 & 70 & 0 \\ 1 & 3 & 20 & 0 \\ 0 & 12 & 0 & 100 \\ 0 & 13 & 10 & 0 \end{vmatrix} = 2{,}258{,}000 \qquad 612$$

$$\text{Feldspar} = \begin{vmatrix} 99 & 0 & 72 & 0 \\ 1 & 0 & 3 & 0 \\ 0 & 0 & 12 & 100 \\ 0 & 60 & 13 & 0 \end{vmatrix} = 1{,}350{,}000 \qquad 366$$

$$\text{Burned Lime} = \begin{vmatrix} 99 & 0 & 70 & 72 \\ 1 & 0 & 20 & 3 \\ 0 & 0 & 0 & 12 \\ 0 & 60 & 10 & 13 \end{vmatrix} = 1{,}375{,}200 \qquad 373$$

Part II. Matrix Theory. Now let's do these same two examples in terms of matrix notation. First, the amber batch:

	Sand	Soda	Slag	Limestone		Desired Analysis
RO_2	99	0	40	0		72.00%
R_2O_3	1	0	10	0		3.00
RO	0	0	50	60	= M	12.00
R_2O	0	60	0	0		13.00

$$\begin{pmatrix} 36000 & -144000 & 0 & 0 \\ 0 & 0 & 0 & 57000 \\ -3600 & 356400 & 0 & 0 \\ 3000 & -297000 & 57000 & 0 \end{pmatrix} = M_{adjoint}$$

Then:

$$(M_{adjoint}) \begin{pmatrix} 72 \\ 3 \\ 12 \\ 13 \end{pmatrix} = \begin{pmatrix} 2{,}160{,}000 \\ 741{,}000 \\ 810{,}000 \\ 9{,}000 \end{pmatrix}$$

Divided by 1080	
2000 lbs.	Sand
686	Soda
750	Slag
8	Limestone

Turning now to the flint batch, we have:

						Desired
RO_2	99	0	70	0		72.00%
R_2O_3	1	0	20	0	= M	3.00
RO	0	0	0	100		12.00
R_2O	0	60	10	0		13.00

$$\begin{pmatrix} 120000 & -420000 & 0 & 0 \\ 1000 & -99000 & 0 & 191000 \\ -6000 & 594000 & 0 & 0 \\ 0 & 0 & 114600 & 0 \end{pmatrix} = M_{adjoint}$$

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THE GLASS DIVISION MEETS AT CORNING

It seems almost unnecessary to report to the Glass Division concerning the meeting on October 12-13 because a large portion of the Division was there. But some readers of THE GLASS INDUSTRY, kept away by duty or distance, may be interested in some account of the greatest Fall Meeting on record.

The Corning Glass Center was the scene. More than 360 people registered for the meeting and enjoyed the facilities placed at their disposal by Corning Glass Works. The spacious lounge and snack bar, the great museum and library, the actual factory where visitors can watch the making of Steuben Crystal while sitting in comfortable grand-stand seats—all these and other features of the Center have been described. Words do not do the place justice. It is seen for the first time with a shock of delighted surprise, and several visits are needed to allow time for seeing and understanding all of it.

With these counter-attractions, in addition to the visiting and conferences that are always such valuable accompaniments to these meetings, it is small wonder that the technical sessions were not exactly crowded. A section of the larger auditorium, the whole of which can seat 2000 persons, was partitioned off for our use. Chairman C. E. Leberknight wielded the gavel, relieved at intervals by Vice-Chairman F. J. Tooley. The solid and varied program of technical papers was prepared by the Committee headed by K. B. McAlpine, while G. J. Bair was in charge of local arrangements. Charles S. Pearce and some of his young men from the home office of the American Ceramic Society were on hand to take care of registrations and ticket sales and to lend an official atmosphere.

Society President H. R. Lillie, who was instrumental in bringing the Division to Corning as a part of the celebration of the Glass Works' Centenary, was at all times the gracious host. Naturally, a large number of Pyregents were in attendance, effective as guides and assistant hosts.

After the luncheon on Friday noon, Chairman Leberknight spoke a few words of welcome and appreciation and introduced S. R. Scholes, who gave some impressions of his visit to Paris in connection with the meeting of the International Commission on Glass. With the exception of a few anecdotes and the relating of some minor incidents of travel, the talk was essentially like the account that has already appeared in THE GLASS INDUSTRY (August 1951). It was of some interest, however, to see on the screen pictures of some of the great men in European glass technology who were either members of the Commission or present at the conference.

Left to right: Dr. J. T. Littleton, Dr. E. U. Condon, and Dr. C. E. Leberknight.

The speaker stressed the importance of the work and the aims of the International Commission and his hope that the Glass Division would continue to give their hearty support. Partly because of the lack of time and partly because reprints are not yet available, he was unable to give summaries of the papers which were presented at the Commission meetings.

In beginning his talk, the speaker remarked upon the tremendous size of the gathering and how much it had grown since the first Fall Meetings at Francis Flint's cottage at Cove Point, Maryland, where fewer than 20 were in attendance 22 years ago.

At the technical session later in the afternoon, Professor Alexander Silverman opened with his paper on the importance of glass collecting. He pointed out that collecting authentic pieces of old glass serves to picture the state of the art at various periods in history, to give us an appreciation of ancient glass makers and glass workers, and to provide, for the use of archaeologists and historians, specimens that might in no other way be preserved for their use.

Left to right: Dr. J. C. Sullivan, Dr. H. R. Lillie, and Dr. J. C. Hostetter.

The remaining papers were technical in character, abstracts of which appear at the end of this report.

Following a Social Hour in the Corning Glass Works Club, which has been moved into the Center from its former quarters in the Hotel Baron Steuben, the group enjoyed a banquet in a portion of the Auditorium converted into a dining room to seat the 400 persons in attendance. Following the dinner, Chairman Leberknight introduced a number of former presidents of the Ceramic Society who were present at the dinner and he also called upon several visitors from overseas who responded with appropriate remarks. Several awards were then made by Trustee K. C. Lyon who presented the Frank Forrest Award to J. V. Fitzgerald for his paper, "Determination of Efficiency of Dealkalization of Glass Surface by Radioactive Sodium", which appeared in the May 1949 issue of THE GLASS INDUSTRY. The S. B. Meyer, Jr. Award was presented to Terry F. Newkirk.

A representative of the Foote Mineral Company then

Dr. J. V. Fitzgerald receives the Frank Forrest Award from Glass Division Trustee Dr. Kenneth C. Lyon for his paper "Determination of Efficiency of Dealkalization of Glass Surfaces by Radioactive Sodium". This article, published in the May 1949 issue of THE GLASS INDUSTRY, was the first paper to be published concerning the application of the tools of the radio chemist and nuclear physicist to the solution of a practical glass problem.

spoke of the contest sponsored by his own firm, to the winners of which 5 awards and some honorable mentions were then made.

The guest speaker for the occasion was Edward U. Condon, who has recently taken up his duties as Director of Research at Corning Glass Works. Having recently served as Director of the National Bureau of Standards, Dr. Condon was able to give an entertaining recital of some of the difficulties attending the management of that institution, particularly in the matter of obtaining adequate funds to carry on the important work in which it is engaged. It seems to be easier, he said, for Congressional Committees to attempt to understand the few thousands for specific smaller problems and the few millions needed to operate the Bureau as a whole than it is for them to try to understand the millions and billions that are being appropriated for other functions of government. Accordingly, there is embarrassing and unreasonable scrutiny of the modest requests made by the Bureau, with the result that it never has as much financial support as it deserves.

Robert S. Curts, who served again (and he hopes for the last time) as Golf Chairman, then exhibited a tablefull of merchandise in attractive variety which had been presented for the golf tournament which had taken place on Friday morning. More prizes were available than there were players participating. Therefore a number of prizes were held up until the following morning, to be presented to the Ladies' Bridge Tournament.

The ladies, meanwhile, had been by no means neglected. They had been given a demonstration-talk on the "Modern Use of Glass" by Harold G. Vogt, Corning, and in the afternoon, a talk "3500 Years of Glass" by James M. Brown, Director of the Glass Center. The ladies were then conducted upon a guided tour through the Center. On Saturday morning, they attended a breakfast-bridge in one of the local parish houses.

Among the afternoon papers, the one by Nelson W. Taylor, "The Ultimate Tensile Strength of Glass", aroused a little controversy. The figure given by Dr. Taylor, 900,000 pounds per square inch, seemed sufficiently astronomical; but during the talk, one of the local men pointed out that certain experimental values had been obtained on small fibers indicating a tensile strength approaching 2,000,000 p.s.i. However, it was refreshing to have Dr. Taylor back on our platform again, ready as ever to go out on a limb and become constructively theoretical.

Attendance at the Saturday morning session, particularly at the Business Meeting following, was cut down somewhat because the buses for the tour through the Keuka Lake Wineries left rather early. Only a few of the old guard remained for the Business session, at which Secretary F. L. Bishop came up with the minutes of the April meeting and certain routine reports were read. Among these was a report from the committee on Standard Samples indicating that these standard glasses are now in storage in charge of Professor Scholes of the New York State College of Ceramics at Alfred. Containers for the samples are on hand, furnished by the Owens-Illinois Glass Company. In these will be placed samples, approximating ½ lb. in weight, of 3 sorts of glass: Sheet glass, furnished by Libbey-Owens-Ford Glass Company; Borosilicate glass in the form of cane, furnished by Kimble Glass Division, Owens-Illinois; Lead glass, also in the form of cane, furnished by Corning Glass Works. The committee announced that these samples are available on request at a fee of $5.00 each. They urge that members

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Recipients of Foote Mineral Lithium Awards discuss their prize-winning papers furthering the technology of lithium in ceramics. Left to right: Grand Award Winner Robert S. Weisz, Edward J. Smoke, Stewart Wilburn McCormick, co-author Dr. M. A. Tuttle, and D. D. Rassner.

GLASS SECTION REPORTS PROGRESS AT NATIONAL SAFETY CONGRESS

The National Safety Council's Glass and Ceramics Section made substantial progress during the past year in arousing the interest of the industry's top management in the worthy cause of accident prevention.

Reporting at the fifth annual meeting of the Section during the 39th National Safety Congress in Chicago, October 8 to 12, James L. Morris, Personnel Director, Federal Glass Company and Chairman of the Section, told of the increase in membership, the work accomplished at meetings of the executive committee, the publication of data sheets on two subjects, heat radiation and tank repairs, the developments in the accident reduction contest, and other features of the Section's program. On the negative side, he spoke of the "false modesty" of some members, who, he said, seemed relucant to step up and shoulder some of the load of promoting the Section's purposes.

Success of the program, Mr. Morris declared, depends on the whole-hearted cooperation of everybody in the industry and he appealed for volunteers to come forward and let the executive committee know that they desire to serve more actively.

In the election of Section officers for the coming year, J. C. Dittmer, of National Lead Company, was chosen to succeed Mr. Morris as chairman. To fill the vice chaiman's post vacated by Mr. Dittmer, Thos. R. Donoghue, of Pittsburgh Plate Glass Company, was selected, and the new secretary of the Section is H. A. Jackson of Frigidaire Division, General Motors Corporation.

In the Section's second day of the meeting, October 9, Mr. Dittmer announced his committee assignments with the following named as chairmen: *Program*—H. V. Gardner, Safety Director, Glass Container Div., Owens-Illinois Glass Company; *Membership*—T. R. Donoghue, Safety Director, Pittsburgh Plate Glass Company; *News Letter*—J. L. Morris, Personnel Director, Federal Glass Company; *Engineering and Health*—Nelson B. Ingalls, Safety Engineer, Norton Company; *Safety Promotion*—Walter W. Wood, Personnel Director, Kimble Glass Company; *Safety Contest*—Harry A. Jackson, Safety Engineer, Frigidaire Division, General Motors Corporation.

In appreciation of his meritorious performance of the chairman's exacting duties during the past year, Mr. Morris, after surrendering the gavel to the incoming chairman, was presented with a framed scroll from the National Safety Council. Presentation, with brief remarks, was made by H. V. Gardner of the Owens-Illinois Glass Container Division at Toledo.

First formal speaker at Monday's session was Dr. W. J. McConnell, Director of Metropolitan Life Insurance Company's industrial health bureau, New York, who outlined a suggested medical program for glass and ceramics plants and discussed, also, the problem of providing medical service in small plants.

When pondering the advisability of establishing a medical service, the question to be settled, Dr. McConnell declared, is not "Can my company afford a medical service?" but rather "Can we afford not to have one?"

He reviewed briefly the many health hazards faced by glass workers who are exposed to toxic metals and solvents and to irritating acids, alkalis, and gases; also to effects of sand dust, the hazards peculiar to glassblowing, and heat exhaustion and other dangers.

"To the great credit of your industry's leaders," he continued, "many of those hazards have been eliminated or placed under control by modernization of processes, use of low solubility lead in glazes, introduction of mechanical handling equipment, improvement in ventilating systems, and other means." But it is regrettable, he added, that the improvements have been confined largely to the larger and newer plants.

An industrial health program, to be effective, Dr. McConnell asserted, must be tailored to serve the needs of a particular plant. Among criteria for such a program he stressed the importance of prompt medical and surgical treatment of injured workers, including attention to minor non-occupation illnesses and injuries, to reduce lost time. He spoke of the importance of replacement physical examinations, annual health checkups of all employees, including executives, so far as practical, and special periodic examinations of men on special assignments entailing peculiar hazards.

Men should be examined, he said, when returning to work after an illness or injury and should also be examined when they terminate their jobs. Coupled with the keeping of complete medical records, this, he said, might eliminate future compensation claims.

"A plant medical service," Dr. McConnell summed up, "is fully justified in the money saved by elimination of accident costs, in the reduction of absenteeism and the improvement in quality of the work done."

Regarding the small plant's problem of providing a medical service, he said, the prevailing belief that it cannot be done economically cannot be substantiated. He told of a cooperative health service established by some 25 small industrial plants situated near each other in Philadelphia. They have one common first aid station, with a staff of physicians, nurses, and other facilities to serve each plant on a definite schedule, and costs are divided proportionately among the 25 units of this co-op. A pamphlet is available, he said, which, in question and answer form, presents the facts which businessmen want to know about this plan.

"The Cost of Public Accidents to Industry," second topic on the program, was handled by another Metropolitan Life man, W. Graham Cole, Assistant Secretary, whose discussion dealt with the need for more attention to accidents occurring to employees while off the job.

"Industry," said Mr. Cole, "has developed a know-how for control of accidents to employees while at work. The tremendous reduction in industrial mishaps definitely proves that it is possible to prevent them. It is time, now, for industrial safety men to turn their attention to reduction of accidents occurring to their men after leaving the plant—to the things that happen on the streets, in their homes, or while they are at play. Industry owes it to itself to help in public accident prevention work, not only from the economics standpoint and the effect of off-job accidents on plant operations, but also from the public relations standpoint as well."

It is quite simple, Mr. Cole said, to integrate an off-the-job safety program with the plant program so that employees will get to thinking of what can happen to them on the streets, in their homes, or when they go off on vacations. It can be done, he suggested, in the foremen's and employees' meetings, or in the educational material, such as posters and house organs, used by the company.

Tremendous good will can also be built, he said, by any company which takes an active part in community-wide accident prevention projects. If there is no local safety council or Chamber of Commerce with whom to cooperate, he suggested that a company could well afford to take the lead in setting up a local organization and developing an effective program to save lives, injuries, and property damages.

Tuesday's session of the Glass and Ceramics Section was devoted to the one subject of radiant heat, with Mr. Dittmer, newly-elected chairman, presiding. It seemed peculiarly appropriate, he remarked humorously in introducing the speakers, that the hazards of radiant heat should be discussed by "Bill" Hazard and what could be done about them by Karl Dunn.

W. A. Hazard, industrial hygienist in the Industrial Relations Division of Owens-Illinois Glass Company, had an array of homemade gadgets before him to demonstrate in somewhat elementary fashion the nature of radiant heat and how it differs from conducted heat. It seems strange, he commented, that the knowledge gained in recent years has not, as yet, been largely applied in glass plants. This knowledge, he declared, definitely indicates that ventilation is not the answer to the problem of providing cooler working conditions around a furnace. The real problem, he pointed out, is the man on the floor exposed to the heat radiating from the furnace.

About the only way to help this worker, he said, is to block off the heat with screens or shields and for this purpose, he stated, corrugated aluminum sheets have been proving highly effective. He referred also to newly-developed jackets and gloves coated with aluminum paint, but he cautioned that the problem of making the aluminum coating stay on the cloth has not yet been licked.

"Shielding," Mr. Hazard concluded, "is easy to do and, in terms of the average ventilating system, it is not expensive."

Karl L. Dunn, industrial hygienist with Corning Glass Works, in his talk on "Control of Radiant Heat", presented a series of slides showing how at the Corning plant corrugated aluminum shields have been suspended from the roof to enclose a furnace, making, in effect, a "room within a room". Instead of being dispersed throughout the plant, the heat radiating from the furnace is thus confined with this barrier, through which it cannot pass except in very minimum volume and is carried off through roof openings by natural convection.

Most impressive of his pictures was one showing the plant timekeeper, a woman, working at her desk located within a few feet of this aluminum barrier. The area into which her operations had been moved, Mr. Dunn said, had formerly been one of the most dreaded hot spots in the plant. Now, with the aluminum barrier to prevent escape of radiant heat, it has become possible for the timekeeper to sit there all day at her desk in comparative comfort. As a substitute for aluminum, it was suggested that gypsum board, attached to supports and coated with aluminum foil, would make a satisfactory barrier. Plastic sheets with aluminum coating have also been tried, it was stated, but these cannot be used if it is necessary to provide means for looking through the barrier.

A question raised regarding the effect of dust settling on the aluminum surface was answered with the statement that dust will not decrease the reflective power of the barrier unless the layer of dust becomes so thick that the metal surface becomes black. An oily film on the surface would also cut down the reflective efficiency of the barrier, it was pointed out.

During the week-long Safety Congress program another glass industry figure, Dr. C. F. Shook, Medical Director of Owens-Illinois Glass Company, appeared at a session of the organization's industrial nursing section, where he spoke on "Psychoanalyzing Management".

The cost of all industrial accidents occurring during 1950, Dr. Shook stated, has been estimated at $2,700,000,000. There were 15,500 deaths from industrial accidents and 84,900 workers were permanently disabled, either partially or totally, while 40,000,000 man days, or one full year's employment for 134,000 employees were lost. These figures, Dr. Shook asserted, should convince management that a good health and safety program is to their benefit.

"With these distressing facts before us," continued Dr. Shook, "we wonder how long industry and its workers can stand these costs. How long can we, as a nation, continue to be drained by such yearly disasters? You can replace machines or parts of machines as they wear out through time and service, but you cannot replace the years of experience held by the operator.

"We in industrial medicine are more and more aware of the fact that the prevention of accidents is dependent as much upon physical and mental fitness of employees as upon mechanical safeguards and safety-first drives."

An extensive and impressive display of accident prevention and protective equipment was arranged, as usual, for Safety Congress visitors. Glass industry men had opportunity to examine displays of protective clothing treated with an aluminum coating, to which Mr. Hazard had referred in his talk at the symposium on Radiant Heat. Several models of suits, coats, and gloves were shown by various manufacturers.

The exposition also included almost everything from goggles to safety shoes, along with dust and fume control systems, mechanical handling equipment, plant protection devices, modern lighting facilities, warning signal instruments, washroom equipment, sanitation supplies, and multitudes of other things. At each display trained technicians were on hand to explain and demonstrate how their products can help in the accident prevention programs.

HAZEL-ATLAS APPOINTMENTS

J. H. McNash, President of Hazel-Atlas Glass Company, has announced that John S. Algeo, formerly Vice President and Sales Manager, has been elected Vice President and General Sales Manager succeeding Walter H. McClure, who will remain with the company as a Vice President and Director.

Roscoe C. Smith, formerly Assistant Secretary, has been elected Comptroller and Assistant Secretary.

RADIANT GAS HEAT IN TELEVISION TUBE MANUFACTURE

By ROBERT C. LeMAY

Selas Corporation of America, Philadelphia, Pa.

During the past five years, over two billion dollars have been invested in television. The heart of the television set, of course, is the picture tube, and hundreds of millions of dollars are being spent for picture tubes alone, within a single year. For the production of these tubes there has been purchased, since World War II, oven equipment costing many millions of dollars.

Probably because television is an electronic industry, most of its original ovens have been electrically heated. Equipment purchases continue, however, in spite of consumer credit curbs and the confusion over color television. Just how far new governmental restrictions will curtail the activity is yet to be seen, but it is reasonable to assume that additional heating equipment will continue to be purchased. While energy cost differentials have not in themselves been sufficient to sell gas in large volume to this suddenly huge field, there has now appeared a development by which gas heated processes can provide superior performance—and assume a more favorable position in the picture tube industry.

At this point it may well be asked where the picture tube industry is situated. Because of its continuing geographical spread, it can only be told where it has located thus far; it still continues to appear at additional locations. Plants thus far have been found in California, Ohio, Illinois, Indiana, Pennsylvania, New Jersey, New York, and Massachusetts. This paper does not cover the manufacture of tube components such as glass enclosures, face panels, metal cones, etc. They are in most cases produced elsewhere, by other industries.

In response to the great demand for picture tubes, concerns in related fields of activity (scientific glassware, radio tubes, lamp bulbs, etc.) continue to enter the field. Throughout most new plants which enter, a fairly uniform growth pattern has been observed. There most operations are performed on single tubes or small groups of tubes in batch type equipment. Frequently these are makeshift, employing heating equipment not designed for the purpose. Operations and handling are largely manual.

As tube production increases (and there have been increases of 3,000 per cent within twelve months), this is usually accomplished by the substitution of continuous heat processing for batch operations. In most plants there is then also installed a rather ingenious overhead conveyor system for carrying tubes between operations. The tubes usually ride in individual cradles, facing upward. It is in this position that they remain after interior coatings have been applied.

To permit a better understanding of principal tube heating operations, there will follow brief descriptions of these as they have been carried out in plants whose production is high enough to justify some use of continuous processes:

1. *Sealing and Tempering Glass-to-Metal Tube "Envelopes."* This operation is required, of course, only where glass-to-metal tubes are used. In fact, because now-vital chrome steel is used in the metal walls, all-glass tubes may well comprise a still larger proportion of total output in the future. For sealing (fusing) metal walls to glass faces at one end and to glass necks at the other, several arrangements are employed. Some producers seal both ends simultaneously, while others do them separately. Some perform the operation on dial type machines, while others carry it out with separate steps through successive stationary units.

Because high temperatures and rapid heating are required, these sealing operations use multiple torch-type oxygen flames burning either city gas or hydrogen. Because the sealing process leaves wide temperature differentials throughout, the tubes are immediately placed in "equalizing" ovens which are held slightly above critical temperatures. Because tubes are moved directly into the room when temperatures have been sufficiently equalized, this amounts to a tempering operation. Most of the earlier equalizing ovens have been electrically heated, operating without recirculation.

2. *Pre-Drying Phosphor Coatings on Tube Faces.* The phosphor or face coating is applied by pouring a purified aqueous material into the inverted tube and allowing the suspended matter to settle on the inside of the glass face. After settling has occurred, the water is carefully decanted and the coating is ready for pre-drying (water evaporation). For this requirement a wide variety of heating methods have been employed, ranging from infrared lamps through resistance heaters outside the tubes to the use of carefully directed warm air within them. Pre-drying represents a small heat requirement, but a critical one, due to the necessity of securing uniform coating thickness across the tube face.

3. *Baking Out Phosphor (face) and Conductive (sidewall) Coatings.* The purpose of the face coating, of course, is to convert cathode rays into light, whereas the Aquadag on the sidewall is a brushed-on electrically conductive coating in which the anode "button" is located. These coatings are "baked out" at approximately 400°C. Most bake-out ovens are of the continuous conveyor type, electrically heated, with forced air circulation. Occasionally they are direct gas fired, and at least two of these are of circular design, utilizing gravity circulation of warm air. A few gas-fired lehrs have been seen. Other units observed include electric box furnaces containing a few tubes each, and a series of individual, cylindrical gas heated hoods, one over each tube. No batch type bake-out ovens have been seen in high production plants where buildings are owned by tube manufacturers. (Those in rented buildings are hesitant to purchase equipment so difficult to move as large ovens.) During the bake-out cycle, certain manufacturers introduce an air stream within the tube. Some heat the air and some do not.

4. *Sealing-in Tube Mechanisms.* This mechanism is frequently referred to as the "gun." Because glass in the plastic state is generally flame heated, various types

Presented before the American Gas Association Sales Conference on Industrial and Commercial Gas.

of gas burners are used here. Although some small plants employ single-position heating, most manufacturers use dial type machines employing open city gas-air burners for preheating and annealing, with oxy-hydrogen or oxy-gas flames between for sealing off. This operation and one described in Section 3 above were pictured in an A.G.A. industrial advertisement for August 1950.

5. *Heating Tubes During the Exhausting Cycle.* As in other types of radio tubes and lamps in general, air is carefully withdrawn in one of the final production stages. When sufficient vacuum has been developed, the exhaust connection is sealed with oxy-hydrogen flames. To facilitate exhausting, this operation is carried out with tubes heated to approximately the same temperatures as those reached during the baking out cycle.

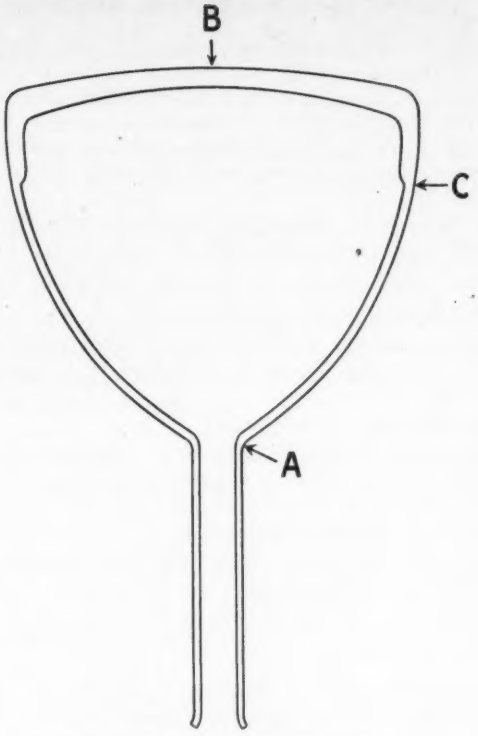
Like bake-out ovens, most exhausting ovens are large continuous units, electrically heated, with forced circulation. In this operation tubes usually pass through the oven on conveyor cars or "buggies," each of which contains exhaust pumps, etc. There is usually also a small induction unit for heating metal parts within the tube neck to assist the removal of occluded gases. The large amount of equipment required for this process makes it a very costly installation.

A few manufacturers have avoided the necessity for high equipment cost by combining bake-out and exhaust steps of the process, usually employing batch-type units for the purpose. In so doing, however, they must fall back on very long heating cycles and sacrifice production.

The foregoing description of accepted production methods seems justified in an effort to outline these relatively new processes to those who are not well acquainted with them. The production of picture tubes is interesting, certainly, but to date has not been the source of much gas load. As has already been stated, however, the future prospects for gas look somewhat brighter. This optimism results from the discovery that radiant gas heat possesses distinct advantages over some of the convection and direct flame heating methods described above.

The television tube envelope is the largest, most complicated glass shape ever heated by industry in mass production. The need for differential or pattern heating of this tube has already been discussed in some detail in the recent Corning Glass Works Service Report entitled "Technique of Heating and Cooling Glass Television Bulbs." Much of the difficulty encountered in heating and cooling these bulbs lies in the fact that glass thickness in the same tube may vary from ¾ inch in the panel down to ⅛ inch in the neck of the funnel. Most attempts to speed up tube heating cycles have immediately resulted in excessive shrinkage (breakage), usually starting in the seal line.

The conventional (convection) oven usually supplies heat to all parts of the tube at the same rate. The effect of this can best be understood by referring to Figure 1. Because of a much lower heat capacity, the thin neck section A rises in temperature far more rapidly than the heavy face section B. The resulting non-uniform temperature rise and accompanying differential thermal expansion exert a severe bending force along the seal line C.



CROSS SECTION OF TYPICAL ALL-GLASS TV PICTURE TUBE

FIGURE 1

To hold this and other differential temperature strains to safe levels, it has long been customary to reduce heat transfer rates and thus prolong heating and cooling cycles far beyond those theoretically required. This expedient has required the use of larger ovens and lehrs or has effectively reduced production rates below those ideally possible.

Obviously, any method employed to reduce glass heating cycles toward theoretical time requirements must accomplish this result by utilizing heat transfer methods which in themselves are capable of minimizing temperature differentials throughout the ware during heating and cooling. This has been accomplished for several types of glassware by the proper application of patterned heat from radiant ceramic gas burners. This method has been successfully employed during the past several years in the short cycle curing and annealing of fluorescent lamps, the dropping and decorating of flat glass, the annealing of glass-to-metal seals, and in other glass heating. In each of these accelerated operations, radiant burners are arranged within the heating structure in patterns which will direct heat rays so that all parts of the ware reach temperature at approximately the same time. Helpful in achieving this result is the characteristic of radiant heat which permits some of it to be released *within the glass itself*. Only part of the heat from these burners is delivered as radiant energy, and for this reason the burned gases leaving the burners are generally utilized for additional heat transfer, such as may be required for preheating the ware. The reduction of

(*Continued on page* 580)

GLASS CONFERENCE PROGRAM

The Twelfth Conference on Glass Problems to be held at the University of Illinois, Urbana, Illinois, Thursday and Friday, December 6 and 7, 1951, will include sessions on (1) Problems and Developments in the Hand Glass Industry; (2) Batch Handling and Feeding; and (3) Training Programs, including a discussion of Job Set-Up Problems.

Program on Hand Glass Problems and Developments, Thursday, Dec. 6, 9:00 A.M.

1. Quality Control in Hand Plants, Nevin Cort, Jr., Bryce Bros. Co., Mt. Pleasant, Pa.
2. Application of Time Studies to Hand Glass Production, Carl Yeater, Fostoria Glass Co., Moundsville, W. Va.
   Thursday, Dec. 6, 2:00 P.M.
3. Some Control Problems in the Manufacture of Colored Glassware, C. E. Leberknight, Kopp Glass, Inc., Pittsburgh, Pa.
4. Paper title to be announced.
5. Panel Discussion on Problems and Developments in the Hand Glass Field.

Program on Batch Handling and Feeding, Friday, Dec. 7, 9:00 A.M.

1. The Selection of Weighing Equipment for the Glass House, F. W. Gilchrist, Toledo Scale Co., Toledo, Ohio.
2. Problems Involved in the Charging of Batch to Continuous Furnaces, A. K. Lyle, Hartford-Empire Co., Hartford, Conn.
3. Batching Plants, Batch Segregation, and Dust Control, John L. Klug, John L. Klug Corp., Rochester, N. Y.

Program on Training Programs in the Glass Industry, Friday, Dec. 7, 2:00 P.M.

1. The Problem in Making Job Set-Ups, R. E. Lawson, Hartford-Empire Co., Hartford, Conn.
2. The Development of Supervisors, Harold Mayfield, Owens-Illinois Glass Co., Toledo, Ohio.
3. The Why, How, and How Much of Job Training, Fred M. Crandall, Owens-Corning Fiberglas Corp., Newark, Ohio.

OWENS-ILLINOIS NAMES JOHN McCORMICK AS CHIEF PHYSICIST

John M. McCormick has joined the General Research and New Development Division of Owens-Illinois Glass Company where he will serve as Chief Physicist, according to James W. Hackett, Manager of the Research Department. In his new capacity, Mr. McCormick will direct the activities of the Physics Section which does work in instrumentation, glass forming materials, process and product studies, physical analysis, and theoretical physics.

Mr. McCormick joined Owens-Illinois following the completion of studies at Massachusetts Institute of Technology in advanced physics and electronics. Prior to this, he had been associated with Preston Laboratories as Assistant Director.

Mr. McCormick received a Bachelor of Science degree from the University of Illinois.

R. R. UNDERWOOD KILLED IN AUTO CRASH

Roy R. Underwood, President of the Knox group of companies, was killed instantly on October 16 when the automobile which he was driving was struck by another car.

Mr. Underwood was born July 27, 1887 at Fisher, Pa. Following grade school education, he went to work as a setting-in boy at a glass plant and progressed through the usual steps until he became a journeyman glass blower. In 1914 he was named Manager of the Marienville Glass Company, and in 1917 was instrumental in organizing the Knox Glass Bottle Company. Under his leadership, the Knox group of companies now numbers twelve. These include Knox Glass Bottle Company, Marienville Glass Company, Wightman Bottle and Glass Manufacturing Company, Pennsylvania Bottle Company of Sheffield, Oil City Glass Bottle Company, Knox Glass Bottle Company of Mississippi, a factory in Palestine, Texas, Lincoln Glass Bottle Company, Denver Glass Bottle Company, Knox Glass Machine Corporation, Midwest Glass Company, and Dover Glass Bottle Company which is still in the construction stage.

Mr. Underwood was President of all of the aforementioned companies and in addition was President of Knox Glass Associates, Inc., a central sales and administrative organization for the group.

Mr. Underwood served as trustee of the Glass Container Manufacturers Institute. In addition, he was extremely active in community projects and served as Director for numerous companies. In December 1948 at a testimonial dinner given by the Glass Bottle Blowers Association of the United States and Canada, Mr. Underwood was presented with an honorary withdrawal card entitling him to perpetual membership in the International Union. He was the only management man in the glass container industry to be so honored.

He is survived by his wife, Vesta; one brother, C. R. Underwood; and one sister, Mrs. W. S. Smathers.

BAUSCH & LOMB ESTABLISHES NEW DEPARTMENT

To expedite procurement of military optical equipment, Bausch & Lomb Optical Company has established a Defense Contract Department.

Kenneth E. Reynolds, who assisted in handling government contracts for the firm during World War II, has been appointed head of the new department. Prime functions of the department are to maintain a "closer liaison with Defense Department representatives of the Army, Navy, and Air Force and expedite procurement of aerial camera lenses, submarine periscopes, mapping equipment, binoculars, searchlight reflectors, optical glass, Stereo Trainers, range finders, optics for bomb sights, and other optics materiel".

Mr. Reynolds was, until recently, Manager of Bausch & Lomb's Analytical Instrument Sales Department.

Inventions and Inventors

Annealing and Tempering

Tempering Sheet Glass. Fig. 1. Patent No. 2,569,951. Filed July 24, 1947. Issued Oct. 2, 1951. This patent expires Sept. 1, 1961. One sheet of drawings. The inventor is Leon Rembaux (deceased) of Brussels, Belgium.

The apparatus comprises four compartments 1, 2, 3, and 4 numbered from the bottom up in the figure. An endless chain 8 carries a series of tiltable trays 9. A sheet of glass is loaded onto the tray at compartment 1 which is supplied with means to preheat the sheet. The tray is then turned into vertical position and is advanced to compartment 2 where it is heated to a high temperature by an electric radiator 23. Compartment 3 subjects the sheet to blasts of hot air from nozzles 20^1 and 20^2 which are adjustable toward and from the sheet. Compartment 4 is heated from the compartment below. The sheet is removed after it leaves the top compartment. Regulating valves are provided at the bottom of the upper three compartments and cooled air is removed from compartment 3 by an exhaust fan 21.

The patent contains five claims and eight references were cited: 1,334,569. Temple et al., Mar. 23, 1920; 1,795,819, Axell, Mar. 10, 1931; 1,999,588, Fox et al., Apr. 30, 1935; 2,026,165, Goodwillie, Dec. 31, 1935; 316,120, Italy, Mar. 21, 1934; 406,606, Great Britain, Mar. 1, 1934; 442, 613, Belgium, Oct. 31, 1941; and 678,870, Germany, July 24, 1939.

Feeding and Forming

Glass Level Regulator. Patent No. 2,565,136. Filed Aug. 7, 1948. Issued Aug. 21, 1951. Two sheets of drawings, none reproduced. Assigned to Emhart Manufacturing Company by Minor G. Kretzmer.

The invention includes a feeler, which reciprocates to determine the glass level in the forehearth, electrically connected with the batch feeder at the tank so as to regulate the feed in accordance with the detected error in the glass level in the forehearth. One of the novel features of the invention is a feeler which is mechanically reciprocated, the downward motion being stopped when it contacts the glass by a brake mechanism.

The patent contains ten claims and the references cited were 1,961,893, Wadman et al., June 5, 1934; 2,032,016, Hitner, Feb. 25, 1936; 2,053,938, Barker, Sept. 8, 1936; 2,098,963, Hexter, Nov. 16, 1937; and 2,380,436, Holdman, July 31, 1945.

Stirrers for Glass Feeders. Fig. 2. Patent No. 2,563,099. Filed Dec. 22, 1948. Issued Aug. 7, 1951. One sheet of drawings. Assigned to Emhart Manufacturing Company by M. M. Cannon.

The invention consists of a pair of vertical stirrers suspended in the flowing glass in the channel of a forehearth. The lower ends of the stirrers are provided with partial screw threads 4 and the stirrers are both rotated in the same direction as shown by the arrows. Means is provided for locating the threads in definite relation to each other. The rotation of these implements stirs the glass and also lifts some of the glass toward the top of the stream.

The patent contains four claims and the references cited were 970,061, Kinser, Sept. 13, 1910; 372,795, Germany, Apr. 3, 1923; and *Pattern Making*, page 125, published 1885 by Crosby, Lockwood and Co., London.

Cooling System for Forming Machines. Fig. 3. Patent No. 2,569,339. Filed Dec. 21, 1949. Issued Sept. 25, 1951. One sheet of drawings. Assigned to Emhart Manufacturing Company by Alan W. Russell.

The object of this invention is to maintain the cooling air used in glass factories at a uniform desired temperature notwithstanding variations in the outside temperature. The drawing is more or less explained by the legends. The pipe 1 takes air from the outside while the pipe 3 supplies heated air from below the tank. The temperature of the cooling air in the pipe 5 leading to the forming machine is measured by thermometer 22 which acts through a controller 24 to adjust the damper 14. This maintains a constant predetermined temperature in the distribution chamber 18 from which the air is discharged against the molds 20.

The patent contains two claims and the references cited were 1,022,188, Geissinger, Apr. 22, 1912; 1,633,028.

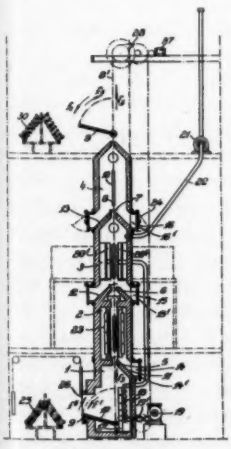


Fig. 1. Tempering Sheet Glass.

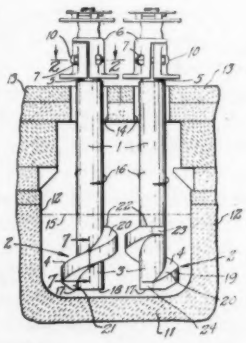


Fig. 2. Stirrers for Glass Feeders.

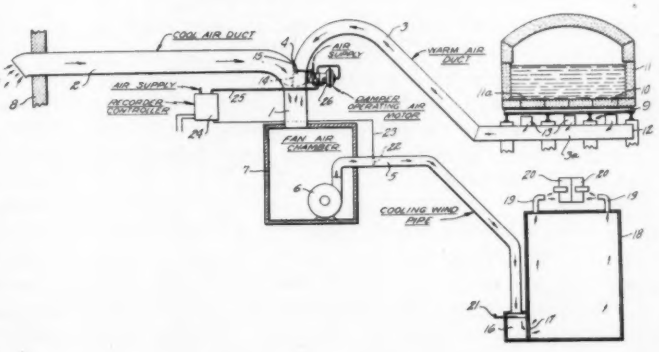


Fig. 3. Cooling System for Forming Machines.

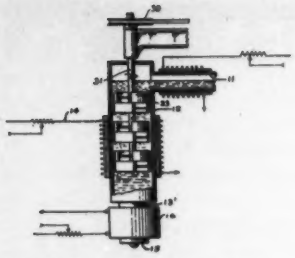


Fig. 4. Stirrer for Feeders.

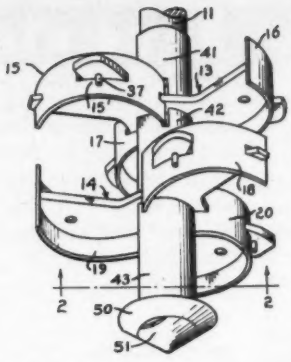


Fig. 5. Stirrer for Feeders.

La France, June 21, 1927; 2,266,217, Kingsland, Dec. 16, 1941; 2,440,052, Lingen et al., Apr. 20, 1948; and 485,370, Great Britain, May 16, 1938.

Stirring Apparatus. Patent No. 2,569,352. Filed July 29, 1949. Issued Sept. 25, 1951. Two sheets of drawings, none reproduced. Assigned to Emhart Manufacturing Company by W. P. Spigener.

This invention comprises a pair of stirrers having a screw thread on the lower ends which are immersed in the glass in a forehearth. The stirrers are supported and rotated by mechanism connected to a vertical post at one side of the forehearth. The arrangement is such that the stirrers may be lifted from the glass, allowed to drain, and then swung to one side where the stirrers may be inspected and replaced if necessary.

The patent contains eight claims and the references were 1,727,606, Klausmeyer et al., Sept. 10, 1929; 2,217,182, Peiler, Oct. 8, 1940; 2,238,800, Mueller, Apr. 15 1941; 2,254,046, Pearson, Aug. 26, 1941; 2,467,809, Cannon et al., Apr. 19, 1949; and 102,916, Great Britain, Jan. 4, 1917.

Stirrer for Feeders. Fig. 4. Patent No. 2,569,459. Filed Aug. 6, 1945. Issued Oct. 2, 1951. Four sheets of drawings. Assigned to Corning Glass Works by C. F. De Voe.

The figure shows a form of the invention adapted for feeding a continuous stream of glass. The glass is electrically heated and it is stirred by three impellers on a vertical shaft. These impellers nearly fill the surrounding casing and they are arranged so that the curved vanes force the glass radially in opposite directions; that is, toward the central shaft carrying the impellers and then outwardly toward the wall of the container. This cuts up any cords that may exist and attenuates them so that they are no longer objectionable.

Another form of the invention is shown for use with a gob feeder. The patent contains nine claims and 12 references were cited.

Stirrer for Feeders. Fig 5. Patent No. 2,570,078. Filed Feb. 5, 1950. Issued Oct. 2, 1951. Two sheets of drawings. Assigned to Corning Glass Works by P. F. Spremulli.

The lower end of a shaft 11 carries two sets of radial arms or webs 13 and 14, the outer ends of which carry impellers 15 to 20. The shape and method of attaching the impellers are clearly shown in the figure. The parts

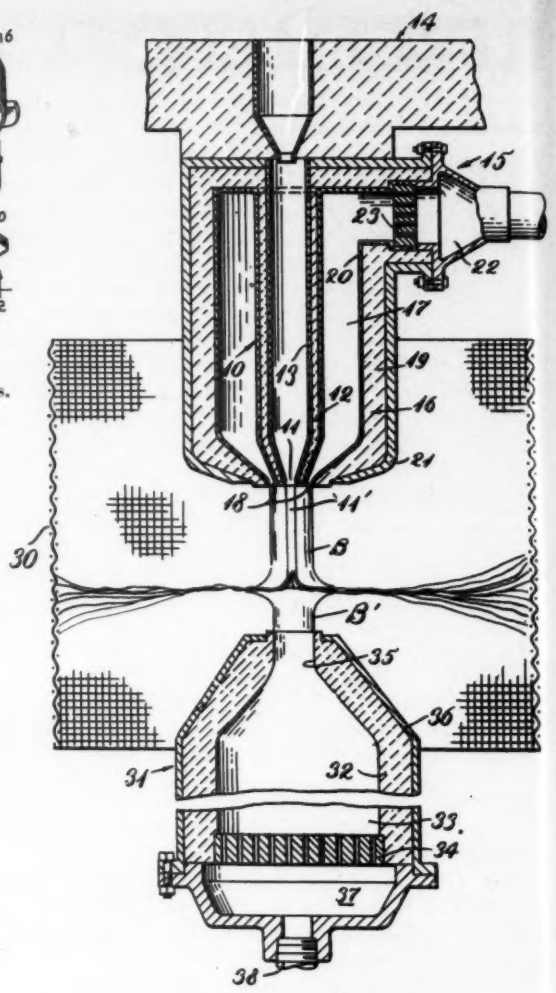


Fig. 6. Fiber Machine.

50 and 51 hold the assembly together and form a conical bottom end. This mechanism is rotated continuously in a position with the conical end just above the feeder outlet. The glass may flow in a continuous stream or be cut into gobs by the usual mechanism.

The patent contains 16 claims and 12 references were cited.

Stirrers for Feeders. Patent No. 2,570,079. Filed Feb. 9, 1950. Issued Oct. 2, 1951. One sheet of drawings, none reproduced. Assigned to Corning Glass Works by P. F. Spremulli.

This invention has some resemblance to the preceding patent, the most noticeable distinction being that below the impellers there is a circular plate of about the same diameter as the impellers. This may be formed by enlarging the bottom end of the above construction or by a separate disk. This stirrer is used in the same way.

The patent contains nine claims and nine references were cited: 1,084,210, Howard, Jan. 13, 1914; 1,603,221, Thomson, Oct. 12, 1926; 1,678,291, Howard, July 24, 1928; 1,737,525, Soubier, Nov. 26, 1929; 1,778,775, Soubier, Oct. 21, 1930; 1,852,218, Peiler, Apr. 5, 1932; 1,884,427, Wardley, Oct. 25, 1932; 2,009,793, Sanchez-

Vello, July 30, 1935; and 2,100,760, Wadsworth, Nov. 30, 1937.

Press and Blow Machine. Patent No. 2,570,817. Filed May 11, 1946. Issued Oct. 9, 1951. Eleven sheets of drawings, none reproduced. Assigned to O'Neill Patents Limited by Clarence C. Kinker.

This machine is of the intermittent turret type carrying eight blank molds and the same number of blow molds alternately arranged. The charge is pressed in the blank mold and neck ring and then lifted for transfer to the blow mold. The blowing operation is performed by three blow heads operating successively. A take-out then removes the finished ware.

The patent contains six claims and ten references were cited.

Glass Compositions

Lead-borosilicate Glass. Patent No. 2,570,020. Filed July 13, 1949. Issued Oct. 2, 1951. No drawings. Assigned to Corning Glass Works by William H. Armistead.

This patent relates to a low-expansion lead-borosilicate glass particularly suitable for use on the manufacture of electronic devices. The patent gives 14 examples of compositions coming under this patent. Examples 8 to 14 are as follows, the compositions being given in per cent by weight on the oxide basis as calculated from their batches:

	8	9	10	11	12	13	14
SiO_2	70	71.6	70	73.4	74.4	70	73.4
B_2O_3	12	13.3	17	13	13	16	13
PbO	11	6.3	6	6	6	6	6
Li_2O	0.25	0.6	0.5	0.6	0.6	0.5	1
K_2O	2.75	1.9	3	2	2	3	2.6
Na_2O	1	1.9	0.5	2	2	0.5	1
Al_2O_3	2	2	2	2	1	2	2
TiO_2	...	...	...	...	...	1	...
As_2O^3	1	1.44	1	1	...	1	...
Sb_2O^3	...	0.96	...	...	1	...	1
Softening pt., °C	757	752	725	750	748	733	742
Softening pt. minus strain pt., °C	282	276	254	274	270	268	253
Exp. coeff. $\times 10^7$ cm./cm./°C	36.8	36.5	37.1	37	38.3	37.4	38.0
Chemical durability, loss in weight, mg./sq. cm.	0.05	0.05	0.06	0.05	0.055	0.06	0.04

The patent contains four claims and nine references were cited: 1,449,793, Taylor, Mar. 27, 1923; 2,282,601, Blau et al., May 12, 1942; 2,314,804, Willson, Mar. 23, 1943; 2,367,871, Kalsing et al., Jan. 23, 1945; 2,498,387, Armistead, Feb. 21, 1950; 195,495, Great Britain, 1923; 219,972, Great Britain, 1925; 753,908, France, 1933; and 533,461, Great Britain, 1941.

Glass Wool and Fiber

Fiber Machine. Fig. 6. Patent No. 2,563,080. Filed Aug. 6, 1947. Issued Aug. 7, 1951. One sheet of drawings. Assigned to Owens-Corning Fiberglas Corporation by Charles J. Stalego.

A chamber 10 contains a supply of molten glass heated by a surrounding chamber 17 fired by a burner 15 and discharged in the form of a stream 11'. The products of combustion are discharged from the opening 18 as an intensely hot high velocity blast B surrounding the stream 11'. A second blast B' of similar temperature and velocity is discharged upwardly from a burner 31 and as the two blasts impinge, the molten glass is thrown outwardly in the form of fine fibers which are collected on an annular screen 30.

The patent contains 20 method and apparatus claims and the references cited were 1,328,446, Odam, Jan. 20, 1920; 2,018,478, Whittier, Oct. 22, 1935; 2,126,411, Powell, Aug. 9, 1938; 2,365,970, Pearce, Dec. 26, 1944; 2,450,363, Slayter, Sept. 28, 1948; and 2,489,242, Slayter, et al., Nov. 22, 1949.

Fiber Machine. Fig. 7. Patent No. 2,566,643. Filed Sept. 21, 1945. Issued Sept. 4, 1951. Two sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by Fay V. Tooley.

This patent, which contains method and apparatus claims, shows a spool 10 carrying flexible carrier members 11 which may be glass filaments or other material. A series of these carriers are unwound from the drum by a pair of rolls 12. On the way to the rolls the carriers pass through a container 13 in which there is a thermoplastic material, such as glass, in the form of a slurry or batch slip. A heater 17 may be used to remove some of

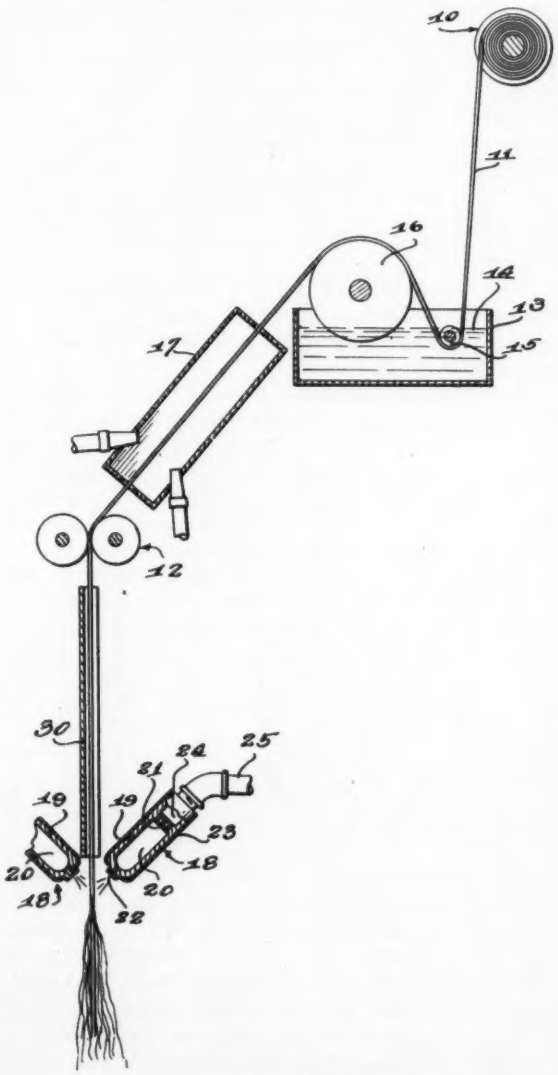


Fig. 7. Fiber Machine.

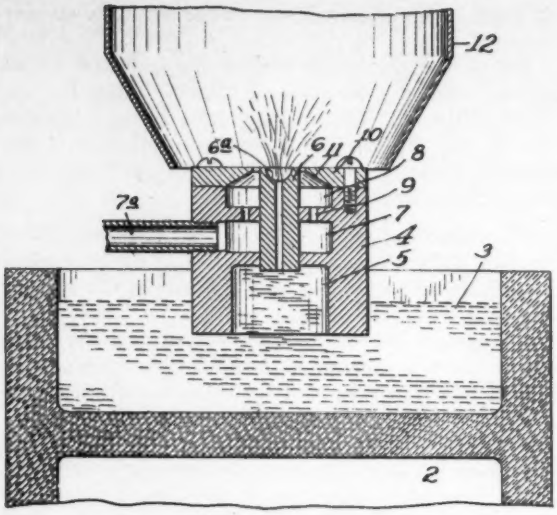


Fig. 8. Fiber Making Apparatus.

the water from the batch without destroying the carrier. A pair of burners 18 are constructed to deliver a blast at very high velocity which may burn the carrier or, if glass is used, melt the carrier and its coating and blow the glass into very fine filaments.

The patent contains 13 claims and the references cited were 2,165,031, Brace, July 4, 1939; 2,171,006, Morgan et al., Aug. 29, 1939; 2,187,094, Pink, Jan. 16, 1940; 2,269,459, Kleist, Jan. 13, 1942; 2,371,213, Batchell, Mar. 13, 1945; and 533,835, Great Britain, Feb. 20, 1941.

Fiber Making Apparatus. Fig. 8. Patent No. 2,569,472. Filed Nov. 3, 1947. Issued Oct. 2, 1951. Two sheets of drawings. Assigned to The O. Hommel Company by Ernest M. Hommel.

This apparatus comprises a forehearth 2 containing the molten glass and a body 4 dipping into the glass. A tube 6 having a concave depression 6a in its upper end forms the nozzle of an aspirator. There is a "chamber 7 to which high pressure frit is supplied by means of a pipe 7a. Compressed air is preferably used". This air is discharged around the tube 6 and this causes the glass to be discharged from the tube in the form of very fine fibers. A casing 12 is connected to a source of vacuum. The fibers are collected on a traveling conveyor as a mat.

One form of the invention shows a similar apparatus discharging downwardly. The patent contains three claims and the references cited were 1,635,653, Williams, July 12, 1927; 1,859,992, Seil, May 24, 1932; 2,062,505, Corkill, Dec. 1, 1936; 2,127,116, Heimburger, Aug. 16, 1938; 2,156,316, Slayter et al., May 2, 1939; 2,221.011, Vieweg et al., Nov. 12, 1940; 2,235,352, Bates, Mar. 18, 1941; and 2,317,895, Drill, Apr. 27, 1943.

Fiber Making Apparatus. Fig. 9. Patent No. 2,569,699. Filed May 6, 1947. Issued Oct. 2, 1951. Three sheets of drawings. Assigned to Owens-Corning Fiberglas Corporation by C. J. Stalego.

This apparatus includes a burner 19 which discharges a very high temperature blast at high velocity. A guide 32 directs a series of primary filaments into this blast. In order to maintain a high temperature in the blast after it leaves the opening of the burner, additional fuel is

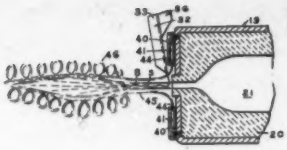


Fig. 9. Fiber Making Apparatus.

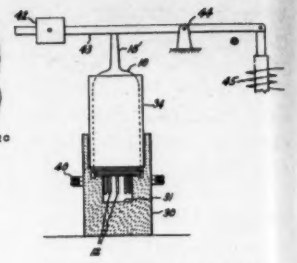


Fig. 10. Method of Making Vacuum Tubes.

supplied from a pair of injectors 40. This forms a protective covering 45 outside the blast and burns so as to increase the size and temperature of the discharge. Very fine fibers are thus formed which may be collected in the usual way.

The patent contains 15 claims and the references cited were 1,128,175, Morf, Feb. 9, 1915; 1,157,984, Herkenrath, Oct. 26, 1915; 2,175,225, Slayter, Oct. 10, 1939; 2,233,304, Bleakley, Feb. 25, 1941; and 2,489,242, Slayter et al., Nov. 22, 1949.

Colored Glass Fibers. Patent No. 2,569,700. Filed June 14, 1947. Issued Oct. 2, 1951. Two sheets of drawings, none reproduced. Assigned to Owens-Corning Fiberglas Corporation by Charles J. Stalego.

In this method, a series of glass filaments are produced by the so-called staple process and these are drawn out by suitable rolls. A coloring substance is applied to the filaments by passing them between two rolls which dip into tanks containing fine glass particles, the selected coloring oxide, and a bonding agent such as sodium silicate. If desired, this coating may be fused to the filament prior to being subjected to a high-temperature high-pressure blast which blows the colored filaments into fine fibers which are collected in the usual manner. Full information as to temperatures and other details are found in the patent.

The patent contains eight method claims and 14 references were cited.

Sheet and Plate Glass

Sheet Bending Machine. Patent No. 2,570,309. Filed Sept. 13, 1950. Issued Oct. 9, 1951. Two sheets of drawings, none reproduced. Assigned to Pittsburgh Plate Glass Company by Lloyd V. Black.

The sheet of glass to be bent is placed on a frame which supports the margin only and heated to the softening point in a furnace. After the glass has sagged, the frame is moved on tracks into position between a fixed upper mold and a vertically movable lower mold. The lower mold rises, lifting the sheet from the frame and pressing it to final shape against the upper mold.

The patent contains 10 method and apparatus claims and the references cited were 1,889,881, Thompson, Dec. 6, 1932; 2,131,873, Goodwillie, Oct. 4, 1938; 2,229,613, Strauch, Jan. 21, 1941; 2,395,727, Devol, Feb. 26, 1946; and 1,599, Great Britain, Dec. 18, 1902.

Miscellaneous Processes

Method of Making Vacuum Tubes. Fig. 10. Patent No. 2,568,460. Filed Dec. 24, 1948. Issued Sept. 18, 1951.

(*Continued on page* 578)

New Interpretation of Expansion Curves and Their Application to Rational Annealing

The variations of Young's modulus and expansion with temperature and time were investigated in a glass of the following composition: SiO_2 37.8, B_2O_3 14.7, BaO 42.0, Al_2O_3 5.0, and K_2O 0.5 by Jean Gillod and the results were reported in the March 1949 issue of *Verres et Refractaires.*

This glass when well annealed had a density of 3.311 at 20°C. and its nD at 20°C. was 1.59192. Young's modulus was measured by sound propagation in a silvered rod subjected to electrostatic vibration. The formula is developed. Samples 24 cm. long and 3 mm. (in some cases 10 mm.) in diameter were made from a perfectly homogeneous annealed melt. The data obtained are shown in Figs. 1 and 2. Fig. 1, Curve *A* (annealed sample), shows a steady decrease in Young's modulus from 8473 at room temperature to below 7500 above 600°C. Curve *B* (quenched sample) shows the slower decrease of the smaller modulus (7684) to about 465°C., followed by an increase (explained by the superimposition of the transformation from a quenched to an annealed state) until curves *A* and *B* meet, when the transformation is completed. Curve *C* (samples quenched after being held at various temperatures and measured at room temperature) shows, for samples held below about 580°C., a constant high modulus of 8473; those held above 750°C. have a constant low value of 7684.

Samples held between 580° and 750°C. (transformation interval) attain room temperature values between 7684 and 8473. Holding at lower temperatures leads to higher moduli, but longer holding times are needed to attain an equilibrium value. The conditions of curve *B* depend on the rate of heating used (in this case 2°C./min.). The conditions of curve *C* are a characteristic of the glass. The effect of transformation on the modulus is discussed in analogy with that of the changes in index of refraction observed on samples quenched after being held at various temperatures and times by Winter (*J. Am. Ceram. Soc.*, 26 [6] 189-99 (1943)). Table I summarizes the equilibrium values of Young's modulus at room temperature after the samples were held at the temperatures shown for the time required to attain equilibrium.

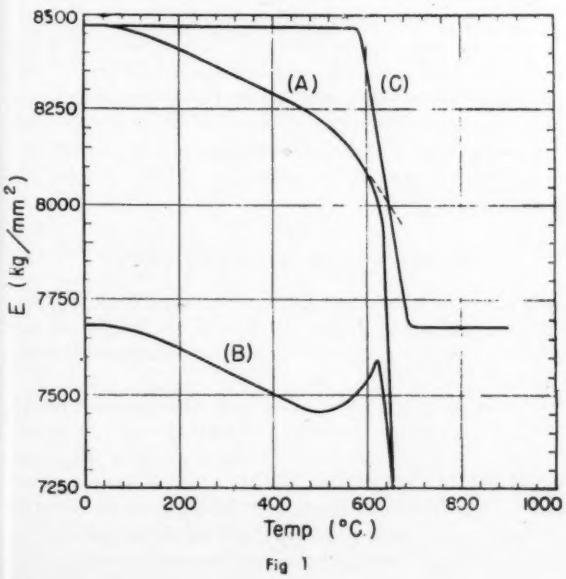


Fig 1

TABLE I

Temp. (°C.)	*E*	Temp. (°C.)	*E*
≤560	8473	645	8047
585	8460	665	7578
600	8391	700	7680
615	8264	≥750	7684
630	8129		

Table II shows, for samples held at three annealing temperatures, the changes in modulus (measured at room temperature) with time.

TABLE II

Time (min.)	Young's modulus 585°C.	600°C.	615°C.
0	7684	7684	7684
15	7850	7932	7944
60			8079
90	8019	8087	
180			8204
270	8164	8228	
570		8304	
600			8264
750	8308		
1530		8374	
2190	8452		
2700	8456		
	At equilibrium		
Time required (min.)	8460 Much over 2700	8391 Over 1530	8264 600

At 585°C. a higher value is obtained in a longer time. This is illustrated on a log time scale in Fig. 2. The anomaly of the expansion curve of glass can be explained by a structural density variation rather than by a stress picture only valid for samples of larger dimensions. The author verified this conclusion by measuring the densities of quenched and annealed samples (3.311 annealed. 3.268 quenched from 850°C.). In an annealed sample of 4 x 2 x 2 cm. no strain could be introduced by rapid cooling 517°, 560°, 570°, and 575°. Only at 585°, when structural changes evidently take place, was strain of 2.1 mμ/cm. observed. At higher temperatures the strains increased. To show the effect of structural changes, Pulfrich index of refraction measurements were made by slicing glass from a 10.3-mm. cube. At 7.7, 5.35, and

(*Continued on page* 581)

OVERMYER MOULD HOLDS ANNUAL IRON CLINIC

The Overmyer Mould Company held its Third Iron Clinic, which is held annually by the company for the purpose of reviewing the progress that has been made in the development of cast iron for use in the manufacture of moulds for the fabrication of glass. A general discussion follows the talks by metallurgists at which time difficulties in problems connected with this branch of the glass-making industry are discussed.

New alloys and combinations of alloys are constantly being added to cast iron to produce better quality, a higher polish, and longer lasting mould equipment. Glass manufacturers attending the Iron Clinic report on the success or failure of the attempts made at improvement.

In addition to the Iron Clinic and general discussion of developments in glass mould metallurgy, the program included a foundry visit, luncheon, golf tournament, cocktail party, and banquet.

C. R. UNDERWOOD TO HEAD KNOX GLASS ASSOCIATES

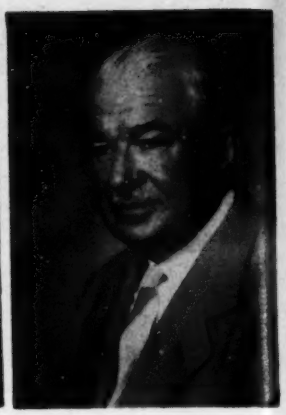
At a special meeting of the Board of Directors of Knox Glass Bottle Company, Chester R. Underwood, formerly Vice President of Knox Glass Bottle Company of Mississippi, was elected President of Knox Glass Bottle Company to fill the vacancy created by the death of his brother, Roy R. Underwood. At a similar meeting, the Board of Directors of Knox Glass Associates, Inc. named Mr. Underwood President of that central administrative organization. G. B. Underwood will continue in his capacity as Vice President.

C. R. Underwood has been closely associated with the Knox group of companies almost since its inception and is widely known throughout the glass container industry. Since the founding of Knox Glass Bottle Company of Mississippi in 1932, he has served as Vice President and General Manager of the entire southern operation of the Knox group of companies.

In addition to the southern units, Mr. Underwood will now direct the activities of the entire Knox group, which includes in all two glass container manufacturing plants in Jackson, Mississippi; a factory at Palestine, Texas; 22 sales offices throughout the south; glass container plants at Sheffield, Pa., Marienville, Pa., Oil City, Pa., Knox, Pa., Lincoln, Illinois, Gas City, Indiana, and Denver, Colorado; plus a nationwide sales organization.

• The formation of a new company to be known as Norton Behr-Manning Overseas, Incorporated has been announced by Norton Company and Behr-Manning Corporation.

L. B. Gordon



D. Peniston

SOLVAY ANNOUNCES EXECUTIVE PROMOTIONS

The Solvay Sales Division, Allied Chemical & Dye Corporation, has announced three executive promotions. Lester B. Gordon has been appointed Vice President, Denman Peniston has been named Director of Sales, and John H. Elleman has been appointed Assistant Director of Sales.

Mr. Gordon has been with Solvay for 36 years, beginning his chemical industry work in 1951 as a salesman in Chicago. He has served as Branch Manager, Division Sales Manager, Assistant Director of Sales and, for the past four years, as Director of Sales.

Mr. Peniston began work as an office boy 41 years ago for the firm which was the predecessor of the present Solvay organization. He has been salesman, Assistant Manager and later Manager of the New York Branch and, for the past four years, he has been Assistant Director of Sales.

Colonel John Elleman joined Solvay Process Division in 1935 as an engineer in its Technical Service Section. He received his engineering education at Purdue University and the United States Military Academy at West Point. Following his graduation from West Point, he served for several years in the Army Corps of Engineers. In 1941 he was transferred to the Solvay Sales Division as a field technical advisor in the Calcium Chloride Department. He again served in the U.S. Army, beginning in 1942, returning to Solvay in 1945. He was appointed Sales Manager of the Calcium Chloride Department at that time, the post he is leaving to fill his present appointment.

HAZEL-ATLAS APPOINTMENTS

J. H. McNash, President of Hazel-Atlas Glass Company, has announced the appointment of Karl Weaver to the newly-created position of Production Manager for the company.

Mr. Weaver has been associated with Hazel-Atlas in various capacities since 1922 and most recently as Superintendent of the company's Clarksburg, West Virginia, plant. In his new position as Production Manager of all plants, Mr. Weaver's efforts will be particularly devoted to the maintenance of and improvement in the quality of the company's products and service.

Current Statistical Position of Glass

Employment and payrolls: During August 1951 employment in the glass industry rose to reach 124,400. Compared with the preceding month's employment of 121,500, an increase of 2.3 per cent is shown. Employment during August 1950 was 121,800 persons, or 2.1 per cent less than for August this year.

Payrolls for August 1951 dropped to reach a preliminary $33,449,087. When compared with the adjusted July payrolls of $35,349,210, a drop of 5.3 per cent is indicated for August. During August 1950 payrolls were $31,346,042, or 6.7 per cent below August this year.

Glass container production, based on figures released by the Bureau of Census, fell off during September to reach 9,133,710 gross. This is 13.6 per cent below the 10,575,070 gross produced during August 1951. During September 1950 production was 8,672,525 gross which, when compared with September 1951 production, is 5.3 per cent less. At the close of the first nine months of 1951, production of glass containers has reached a total of 92,943,627 gross and at the close of the same period in 1950, production was 77,079,819 gross. Therefore, glass container production at the three-quarter mark this year is running 15.8 million gross, or 20.5 per cent, ahead of this same period in 1950.

Glass container shipments during September 1951 also fell off and were 9,632,719 gross. This shows a decrease of 10.9 per cent from the previous month's shipments of 10,822,367 gross. Shipments during September 1950 were 10,617,050 gross, or 9.2 per cent below September this year. At the close of the January-September 1951 period, shipments of glass containers have reached 89,855,426 gross as compared with total shipments of 80,893,125 gross at the close of the same period in 1950. Thus, at the close of the third quarter 1951, shipments are 8.9 million gross, or 11 per cent, ahead of last year.

Stocks on hand at the close of September 1951 were 9,838,855 gross, or 2.6 per cent less than the 10,102,186 gross on hand at the end of August. Stocks at the close of September 1950 were 4,865,187 gross.

Due to a delay in the compilation of figures showing the production, shipment, and stocks of automatic tumbler ware and manufacturers' sales of machine-made table, kitchen, and household glassware for September 1951. THE GLASS INDUSTRY is unable to publish these statistics in this issue. It is planned to include these data in this department in the December 1951 issue.

GLASS CONTAINER SHIPMENTS

(All figures in Gross)

	September 1951
Narrow Neck Containers	
Foods	1,431,912
Medicinal & Health Supplies	998,000
Chemicals, Household & Industrial	628,943
Beverages, Returnable	321,224
Beverages, Non-returnable	10,362
Beer, Returnable	200,766
Beer, Non-returnable	1,143,650
Liquors	919,753
Wines	250,907
Toiletries & Cosmetics	437,815
Sub-total (Narrow)	6,343,332
Wide Mouth Containers	
Foods	*2,158,081
Dairy Products	338,242
Medicinal & Health Supplies	239,857
Chemicals, Household & Industrial	88,408
Toiletries & Cosmetics	106,532
Packers' Tumblers	122,499
Sub-total (Wide)	3,053,619
Total Domestic	9,396,951
Export Shipments	235,768
TOTAL SHIPMENTS	9,632,719

* This figure includes Home Canning.

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in Gross)

		Production September 1951	Stocks September 1951
Foods; Medicinal & Health Supplies; Chemcals, Household & Industrial; Toiletries and Cosmetics	Narrow Neck	3,258,927	3,520,652
	Wide Mouth	*2,268,172	*3,410,864
Dairy Products		345,742	364,714
Beverages, Returnable		409,784	559,721
Beverages, Non-returnable		8,045	22,746
Beer, Returnable		237,568	255,913
Beer, Non-returnable		1,322,665	555,670
Liquors		931,144	710,509
Wines		247,887	309,672
Packers' Tumblers		103,776	128,394
TOTAL		9,133,710	9,838,855

* This figure includes Home Canning.

CORNING APPOINTMENTS

Paul W. Schulz, Production Control Manager of the Technical Products and Consumer Products Divisions of Corning Glass Works, has been named Manager of the company's Charleroi, Pennsylvania, plant, according to an announcement by President William C. Decker.

At the same time, Mr. Decker announced that John J. Gottko, chief cost accountant at the main plant, will succeed Mr. Schulz, and replacing Mr. Gottko will be F. W. Bobrick.

Mr. Schulz has been associated with Corning Glass Works for the past 24 years, having joined the company's Wellsboro, Pennsylvania, plant in 1927. He was later transferred to the Fall Brook plant in Corning, and in 1938 became assistant manager of quality control at the main plant. In 1945 he was appointed Production Planning Manager and was made Manager of Production Control the following year.

Mr. Gottko joined Corning in 1946 as chief cost accountant, following his association with Thatcher Glass Manufacturing Company. Mr. Bobrick has been with the company for 16 years, serving in various accounting capacities until 1946 when he was appointed assistant manager of the plant's cost department and later plant accountant.

HANDMADE INDUSTRY CARRIES ON INTENSIVE PROMOTIONAL CAMPAIGN

To educate consumers, retailers, and distributors to a better appreciation and understanding of American handmade glass, and to aid dealers by sending pre-sold customers into the stores to buy it, the handmade industry formed a trade group about three years ago to carry out a continuing, year-round educational and promotional program.

Known as Glass Crafts of America, this group has developed a basic, sound campaign built on the principle that consumer education is not seasonal or spasmodic but continuous.

Handmade glass plays a vital role in today's home furnishings picture. Its creators must fill an exacting and discriminating demand, for women are more style-, color-, and quality-conscious than at any previous time.

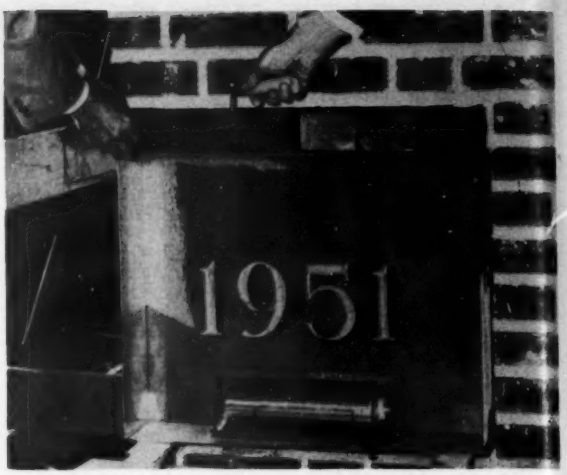
Merchandising and selling personnel must keep a step ahead of the customer in style and product information. Of glass, especially, has there been a great deal of misinformation and a general lack of authoritative knowledge. This lack existed in both store personnel and customer.

How to judge fine glass; how to select glassware patterns; essential glassware for adequate table service; how to use glass decoratively in every room in the house; and why handmade glass is one of the homemaker's soundest investments are among the subjects which set the theme for the consumer education and sales training program of Glass Crafts of America.

This story is being told to millions of Americans by press, radio, and TV. Every week throughout the year 556 daily newspapers and 832 radio stations broadcast some phase of the American handmade glass story. Television stations reaching 90 per cent of the nation's set-owners have broadcast pointers on using American handmade glass a total of hundreds of times on their women's homemaking programs. Consumer magazines reaching millions of homes have carried the handmade glass story. Trade magazines in the retail field have carried "case history" articles on how stores merchandise handmade glass profitably. Reprints of magazine features on handmade glass have been supplied by Glass Crafts to home demonstration agents and home economics teachers all over the country. Exhibits of American handmade glass have been made available to many universities.

While carrying out this program to put the consumer in a mood to buy American handmade glass, Glass Crafts of America has been further aiding the dealer by means of a monthly newsletter. With a circulation of 18,000, this merchandising newsletter keeps the dealer informed of Glass Crafts activities to help him sell more glass; offers him suggestions to stimulate sales of glass; tells him how other stores are selling more glass. Reprints of consumer magazine features on handmade glass which have been sent to the dealer by Glass Crafts form a handy reference library. Dealers, merchandise managers, and buyers in all parts of the country have responded enthusiastically to the Glass Crafts program.

• H. C. Meyer, President of Foote Mineral Company, has announced the appointment of Gordon H. Chambers as executive Vice President, S. C. Ogburn, Jr., L. G. Bliss, and Felix B. Shay as Vice Presidents.



CORNERSTONE LAYING AT ALFRED

A unique glass cornerstone, contributed by Corning Glass Works, was ceremonially laid on Saturday, October 20, in the new classroom and laboratory building to be known as Binns Hall, New York State College of Ceramics.

The "stone" is a block of clear glass of the composition used for large astronomical telescope mirrors, having low thermal expansibility and great resistance to weathering. It is 24 inches wide, 18 inches high, and 8 inches thick. In the casting, a cavity was made in the bottom in which has been placed a glass capsule containing a number of documents marking occasion and date, and describing the College and Alfred University. The papers are wrapped in aluminum foil for protection against light, and the capsule was filled with argon gas before sealing.

Following the casting of the 300-lb. block in a mold formed of soft insulating brick, the painstaking work of grinding and polishing and engraving the date was done by Walter Harriman, who was present to supervise setting the stone.

President M. Ellis Drake of Alfred University presided, and gave a brief historical sketch of the School and College. Dr. W. W. Shaver, Corning Glass Works, brought greetings and congratulations as President of the Ceramic Association of New York. Mr. B. Colwell Davis, Vice-Chairman of Trustees, spoke for the Trustees of Alfred University.

The principal address, a scholarly discussion of "Freedom and Education," was given by Charles Garside, Acting President, State University of New York, who was introduced by John F. McMahon, Dean of the College. Mr. Garside then laid the cornerstone. Assisting in the ceremony were three daughters of Charles Fergus Binns, first Director of the School of Clayworking and Ceramics, 1900-1931, and a daughter of John J. Merrill, who was prime mover in establishing the School.

Work on the new Binns Hall proceeds at such a rate that it will be under roof in November, and ready for occupancy in the Fall of 1952. The outlay by the State, including cost of equipment, will be well over one million dollars. The new structure, together with the 1932 building, Merrill Hall, to which it is joined, will provide the College with unrivalled facilities.

New Equipment and Supplies

NEW ELECTRIC ANNEALER

Forter-Teichmann Company, 711 Penn Avenue, Pittsburgh, Pa., has announced the availability of its new electric annealer. Designed and built with the cooperation and to specifications of the Sylvania Electric Products, Inc., these annealers are being used for the annealing of bulbs, stems, flares, and other small glass articles required in the manufacture of radio and electronic tubes.

The annealer is electrically heated and completely automatic in temperature control. The arrangement of the special electric heating elements affords a high economy of operation and ready accessibility of elements for replacement without interrupting production. The speed of the wire-mesh belt carrier is controlled through a variable speed motor drive.

Well-insulated and compact, the annealer occupies only about 3 feet x 14 feet of floor space. It is equipped with an optional cooling system to cool the annealed glass to a comfortable handling temperature, a feature especially desirable when running small items at high speeds.

Although normally furnished with an all-purpose wire mesh belt, other belts are available for special purposes. The annealer is also available with manual temperature control as an alternate to the completely automatic temperature control shown.

NORTON GRINDING MACHINE

Norton Company, Worcester 6, Mass., is manufacturing an 18″ Type LCTU Cylindrical Grinding Machine made in six work lengths from 18″ to 120″ and designed for light type work requiring up to 18″ swing for rapidly grinding up to finest limits of accuracy and finish.

Available as a plain machine or as a semi-automatic, work is produced rapidly with a minimum of effort because of the advanced operating ease offered. Such features as pre-set truing and grinding speed, click-count wheel feed indexing, automatic work rotation, and coolant flow control greatly simplify operation.

Long full bearings enclose a major portion of the wheel spindle and keep it on its fixed center line under any condition of load. This unit is particularly suitable for roughing jobs or for the finest finishing operations.

WATER BATCH TEMPERATURE CONTROL

Fisher Scientific Company, 717 Forbes Street, Pittsburgh 19, Pa., has announced the development of a new Fisher Isotemp Bath, designed for precise control of water bath temperatures.

The constancy of bath temperature claimed for the new bath is plus or minus 0.005 degrees centigrade over its entire range of about minus 5 to plus 107 degrees centigrade. Actual tests have produced variations as small as two-thousandths of a degree over a long period of time, according to the company's release.

The unit employs an electronic circuit to control a 400-watt and an 800-watt heater. The heating elements, stirrers, and controls are contained in a central column with all connections made through the bottom of the 15 x 15″ Pyrex brand glass bath, thus providing an unobstructed top surface for inserting samples. Stirring is effected by a 1150 rpm. motor and propellers so that the entire 10 gallon water (or light mineral oil) content is constantly in motion.

BELT CONVEYOR CARRIER

Stephens-Adamson Mfg. Company, Aurora, Illinois, has announced the addition of a new belt conveyor carrier to its line of standard and special carriers.

The new unit is particularly effective and on most applications need only be installed at intervals of 50-100 feet. The "training rollers" respond instantaneously to any shift of the belt off dead center and tilt the carrier into an angular position with respect to the direction of belt travel. This quickly returns the belt to center and the carrier resumes its normal position. Edge wear of the belt is negligible with this carrier and its use insures against any possibility of serious belt damage due to improper training.

FLUORESCENCE ANALYSIS UNIT

North American Philips Company, Inc., Research and Control Instruments Division, 750 South Fulton Avenue, Mount Vernon, New York, now has in production a new Norelco Fluorescence Analysis Unit which incorporates many design improvements to facilitate rapid qualitative and quantitative analysis of constituents in minerals, ores, chemical mixtures and compounds, metals, and alloys.

Specimens under analysis are exposed to an intense beam of exciting X-radiation. This results in individual X-radiations being generated by elements susceptible to such excitation. The combined radiations representing the various constituents are passed through a special collimating system to a crystal which serves as an analyzer and which, by proper positioning, reflects each of the individual radiations at a specific angle. Intensities are measured by means of a Geiger counter, arranged together with a crystal and its angulating mechanism on a specially designed goniometer.

As distinguished from X-ray diffractions which gives precise data about atomic structure, fluorescence analysis provides precise quantitative and qualitative data with respect to the elements present. Difficult analyses involving solids, semi-solids, and liquids can be carried out in much less time than when ordinary chemical methods are employed. Also, fluorescence analysis is entirely non-destructive and permits analysis of very small specimens.

CATALOGS RECEIVED

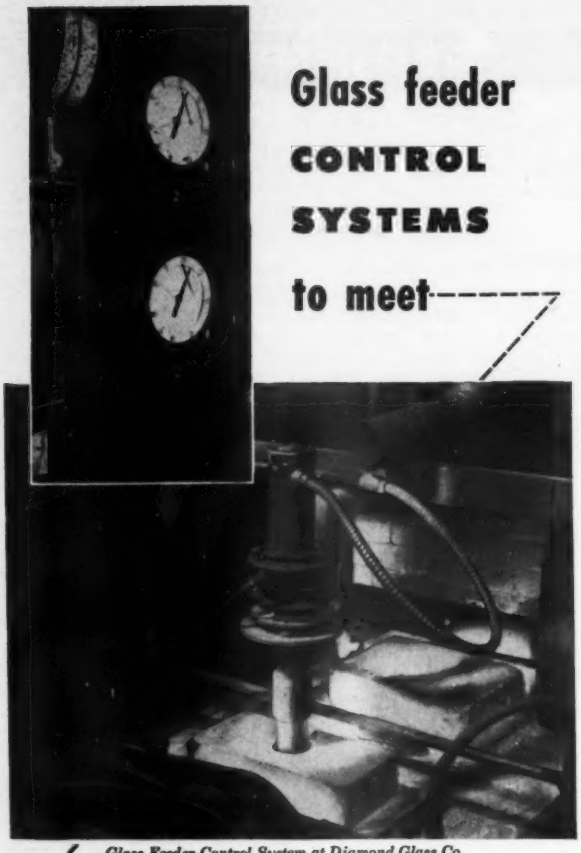
Laclede-Christy Company, 5900 Manchester Avenue, St. Louis 10, Missouri, has announced publication of Bulletin 41, "Castable Refractories," devoted to castable products and applications.

The booklet includes a discussion of the character, features, uses and selection of castable refractories; product descriptions; applications, including burner ports, car tops, door linings, boiler settings; installation information; estimating requirements; physical characteristics; and where the product may be obtained.

Cambridge Wire Cloth Company, Cambridge, Maryland, has published its Bulletin No. 101 which is devoted to its industrial wire cloth for filtration, sizing, screening, cleaning, straining, catalysis, dehydration, and conveying.

Well illustrated with various screens of weave, the folder includes photographs of the company's weaving room, together with brief outlines of specific problems solved by the application of unusual or difficult types of cloth.

American Structural Products Company, a subsidiary of Owens-Illinois Glass Company, Toledo 1, Ohio, has released a 16-page booklet outlining the important role of glass block, especially as a replacement for worn-out window sash, during this period of material shortages.



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HONEYWELL control systems are controlling over 400 forehearths in the United States . . . producing all types of ware . . . providing the ultimate in accuracy and speed of response of temperature measurement and control.

Now, in addition to the reliable thermocouple system for temperature measurement, the industry is quickly taking advantage of the new Brown *Radiamatic* System with *ElectroniK* Temperature Controls.

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As a team, they add up to *better ware quality, higher percent pack* and *more production at lower cost!*

Catalog 9300 and Data Sheet 1.4-1a provide complete details. Write for your copies.

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MINNEAPOLIS
Honeywell
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GLASS DIVISION MEETS . . .

(*Continued from page* 557)

of the Division take these samples and cooperate by determining physical properties, so as to enhance their value for the use of any and all laboratories as checks upon their own methods and determinations.

All in all, it must be said that the meeting was a highly successful one. Even though the technical sessions could not successfully compete with the other attractions and consistently draw the entire crowd, and though they were marred somewhat by the continuing custom of some authors of preparing slides that have such microscopically small numbers and letters as to be virtually illegible by the audience, the sessions were profitable and brought out a number of papers whose publication we await with interest. Perhaps the most important feature of the meeting was the opportunity automatically presented to the members of the Glass Division to see the beauties and glories of the magnificent Glass Center and to get the inspiration that comes from seeing the most advanced achievements in all fields of glassmaking.

Following are brief abstracts of the technical papers presented:

1. **Flame Photometric Estimation of the Durability of Glass.** *By M. E. Nordberg and D. L. Rothermel, Corning Glass Works, Corning, N. Y.*

A miniature method for estimating glass durability by a flame photometric determination of the alkalis leached out of one gram of glass powder is described. Values obtained by this method are in good agreement with titration values obtained by leaching a 10 gm. glass powder sample. Determination of individual alkalis leached out permits calculation of the minimum thickness of glass attacked.

2. **Ray Stopping Glasses.** *N. J. Kreidl and G. F. Brewster, Bausch & Lomb Optical Co., Rochester, N. Y.*

The fundamental principles of X- (or gamma) ray and thermal neutron absorption are discussed, with reference to examples of suitable glasses. The development of new X-ray absorbing lead-tantalum borate and thermal neutron absorbing cadmium-zirconium-titanium borate glasses are presented.

3. **Vitreous Silica.** *By W. W. Winship, Freeport, N. Y.*

Vitreous silica, although found in impure forms in nature and known as a scientific curiosity since 1839, has only been in commercial production for about 40 years.

While silica constitutes the backbone of ceramics, the manufacture of pure silica products possessing high chemical and thermal stability presents unique problems. These are covered, with data as to the history, properties, and applications of the ware.

4. **Importance of Glass Collecting.** *By Alexander Silverman, University of Pittsburgh, Pittsburgh, Pa.*

Glass collecting domestically and abroad is important as an historical record of the types and interests characterizing individual nations at various times or periods. Not only is the art of interest to the glass technologist, but also the composition and method of treatment of articles which have been collected.

The art itself is valuable because of possible design applications from specimens which are already available from various nations and from various periods. In other words, a glass collection is important for what it tells us of the past and the present regarding manufacture and treatment and design, as well as for the suggestion it may afford to the artist and the technologist for future production.

5. **Thermal Expansion of Some Simple Glasses.** *By M. D. Karkhanavala and F. A. Hummel, Pennsylvania State College, State College, Pa.*

(*Continued on page* 574)

Rx: ALCOA ALUMINA FOR FINE GRINDINGS

Long the symbol of prescription druggists, the mortar and pestle represents fine grinding—and fine grinding calls for ALCOA Alumina.

It is no coincidence then, that Coors Porcelain Company, Golden, Colorado, chose ALCOA Alumina as the main component of their new mortar and pestle. Completely vitrified and non-porous, the alumina surfaces are extremely resistant to abrasion . . . unaffected by tungsten carbide scribers . . . only slightly scratched by diamond. ALCOA Alumina is especially suited to this product because its purity and hardness (9 on Moh's scale) permit extra fine grindings without fear of contamination.

ALCOA Alumina is aluminum oxide, a crystalline material with very sharp edges and corners. It is from this characteristic that alumina derives its value as an outstanding, fast-cutting abrasive.

ALCOA Alumina is only one of the versatile ALCOA Chemicals used throughout industry to make *better* products do a *better* job. Electrical insulators . . . high-temperature refractories . . . grinding balls . . . rubber . . . glass . . . are but a few of the hundreds of products which have been measurably improved by ALCOA Chemicals. Perhaps they can benefit *your* product. Write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 613L Gulf Building, Pittsburgh 19, Pennsylvania.

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Manufacturers of amber glass have found these advantages to be realities when using Calumite.

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Perhaps we can help you in your particular problem.

The Calumite Co.
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GLASS DIVISION MEETS . . .

(*Continued from page* 572)

In order to obtain a better understanding of the contribution of different oxides to the thermal expansion of glasses, a number of glasses of widely different composition were examined. The increased expansion which is noticeable in glasses above the transition range gradually disappears as the basicity of the glass increases. In contrast to the viscosity of glasses, the thermal expansion is not materially affected if a noble gas type cation is replaced by a non-noble gas type cation of the same size.

6. **Helium Diffusion Through Glass.** *By F. J. Norton, General Electric Co., Schenectady, N. Y.*

Using the mass spectrometer as an analytical tool, the diffusion of helium has been studied through fused silica and other glasses of varying composition. Due to the great sensitivity of this device, measurements could be made to —80°C. and lower to SiO_2. Other glasses with very small helium permeation velocities were measured to low temperatures.

7. **Calculated X-Ray Mass Absorption Coefficients of Glass Components.** *By G. F. Brewster, Bausch & Lomb Optical Co., Rochester, N. Y.*

X-ray mass absorption coefficients of some elements and oxides used in glassmaking have been computed from short wave lengths to characteristic K absorption edges.

8. **The Ultimate Tensile Strength of Glass.** *By N. W. Taylor, Minnesota Mining and Manufacturing Co., St. Paul, Minn.*

The author's theory (*J. Applied Physics., November*, 1947) gave a satisfactory representation of data on the relationship of fracture stress and time for fracture. One of the assumptions in this theory is that Hooke's Law is valid right up to the point of fracture.

It it well known the velocity of crack propagation in glass is roughly one-third the velocity of sound. If we make the naïve assumption that the velocity of crack propagation is controlled by a modulus f^* having the same dimensions as that which controls the propagation of sound, we can write the formal equation $c_{,\text{crack}} = (f^*/p^{1/2}$ in analogy with the expression $c_{,\text{sound}} = (E/p^{1/2}$ where c denotes velocity, p is the density, E is Young's Modulus and f^* is the ultimate or limiting stress which opposes the advancement of the crack. It follows that f^* would be roughly one-tenth that of E.

An examination of the natural variations of ionic radii in crystals and glasses shows that variations up to 10% do occur, but larger variations than 10% result in a breakdown of the structure. If Hooke's Law is valid, a 10% increase in bond distance would correspond to an ultimate stress f^* which is $0.1E$. The coincidence of this ratio with that given by data on the velocity on fracture lends strong support to the existence of a limiting modulus f^*.

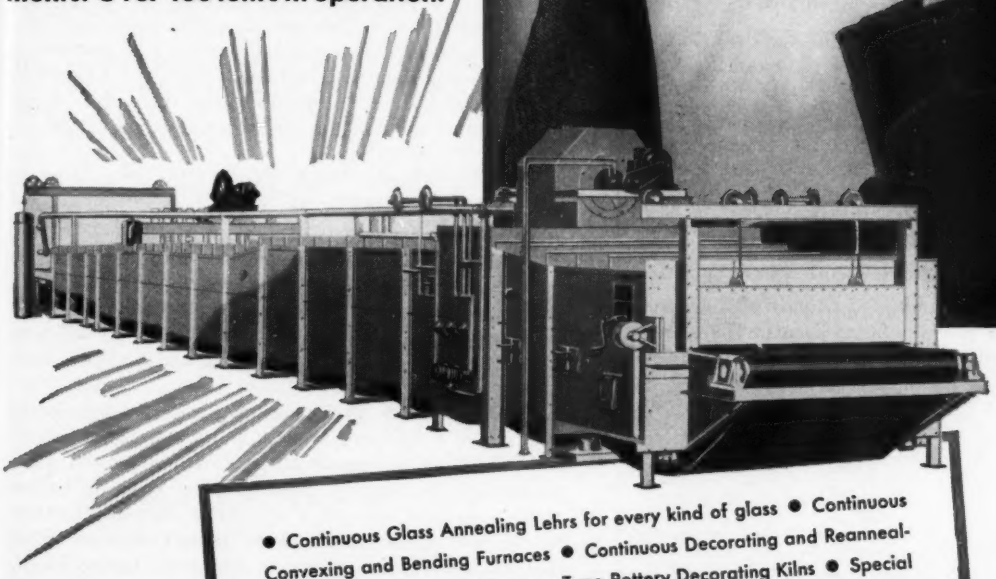
9. **The Application of Rate Process Theory to Electrical Conductivity in Glass.** *By D. A. Stuart and O. L. Anderson, Cornell University and University of Utah.*

The electrical conductivity of glass has long been known to be a function of temperature and composition. This was first empirically established by Fossereau in 1882. However, the temperature dependence of the resistivity would seem to follow different laws at high and low temperatures. Using the rate process theory, an equation is developed giving the dependence of the resistivity upon temperature. It is shown that at high and low temperatures the equation is reducible to the known empirical forms. It also is shown as a consequence of the theory that glass may, at low temperatures, be non-ohmic in character as reported by Poole. Further, Poole's equation for the dependence of the resistivity upon field strength is shown to be a direct consequence of the theory.

• The Western Division Sales Office of the Wheelco Instruments Company has been moved to larger, more convenient offices at 2320 Milwaukee Avenue, Chicago.

IN THE MAKING OF GLASS BLOCK

Extremely high production rates are combined with consistent quality. The industry calls on Surface Combustion precisely controlled annealing lehrs to meet these requirements. Over 400 lehrs in operation.



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DETERMINANT AND MATRIX THEORY . . .

(*Continued from page* 555)

Then:

$$\begin{bmatrix}\text{Sand}\\ \text{Soda}\\ \text{Feld}\\ \text{B.L.}\end{bmatrix} = (M_{\text{adjoint}}) \begin{bmatrix}72\\ 3\\ 12\\ 13\end{bmatrix} = \begin{bmatrix}7{,}380{,}000\\ 2{,}258{,}000\\ 1{,}350{,}000\\ 1{,}375{,}200\end{bmatrix}$$

Where the following evaluation was used:

$$\text{Sand} = 120000 \times 72 + (-420000)3 + 0 \times 12 + 0 \times 13 = 7{,}380{,}000 \rightarrow 2000$$

$$\text{Soda} = 1000 \times 72 + (-99000) \times 3 + 0 \times 12 + 191000 \times 13 = 2{,}258{,}000 \rightarrow 612$$

$$\text{Feld} = (-6000) \times 72 + (594000) \times 3 + 0 \times 12 + 0 \times 13 = 1{,}350{,}000 \rightarrow 366$$

$$\text{B.L.} = 0 \times 72 + 0 \times 3 + 114600 \times 12 + 0 \times 13 = 1{,}375{,}200 \rightarrow 373$$

and the final answers were divided by 3690.

Section III. Fining Agents.

Returning again to the flint batch, let's say that we want to have 0.25% SO_3 in the final glass and 0.15% F_2 in the final glass. This could be computed either by making a 6 by 6 determinant or matrix, which becomes very tedious and difficult, or by including them in the final batch after it has been computed. We shall use gypsum and fluorspar as our sources of SO_3 and F_2.

In our flint batch, we have a total weight of oxides equal to 3105.7 lbs. per 2000-pound sand batch. We first find the number of pounds of SO_3 and F_2 necessary to yield the above percents.

$$(3105.7)\ (0.0025) = 7.7643 \text{ lbs. } SO_3$$
$$(3105.7)\ (0.0015) = 4.6586 \text{ lbs. } F_2$$

Since in gypsum we have 36.3% CaO and 38.9% SO_3, and in fluorspar we have 71.8% CaO and 24.35% F_2 in the final glass, we find that:

$$\text{lbs. } CaSO_4 = 7.7643/0.389 = 19.96$$
$$\text{lbs. } CaF_2 = 4.6586/0.2435 = 19.13$$

and then:

$$\text{lbs. CaO in glass from } CaSO_4 = 19.96\ (0.363) = 7.25$$
$$\text{lbs. CaO in glass from } CaF_2 = 19.13\ (0.718) = 13.74$$
$$\text{Total} = 20.99$$

This total is the number of pounds of CaO produced in the final glass from the fining agents. Therefore, if we subtract it from the pounds of RO produced by the burned lime, the remainder will be the amount of RO needed from the burned lime to retain the desired 12.00% RO in the final glass.

$$\begin{array}{r} 373 \\ 21 \\ \hline 352 \end{array}$$

This final remainder divided by the percent RO in burned lime will yield the corrected pounds of burned lime necessary to retain 12.00% RO. In this case it would be simply 352.

Our final batch with fining agents added to yield 0.25% SO_3 and 0.15% F_2 is: (with a small error, 0.40%, due to the inclusion of SO_3 and F_2)

Sand	2000
Soda	612
Feldspar	366
B.L.	352
Gypsum	20
Fluorspar	19

Summary

Matrix theory as such has just been touched in this paper. In order to use it well, it is really necessary to obtain a good text on the subject and prepare one's own system of applying it to the calculation of batches.

The system of introducing fining agents presented in Section III is not an exact one since the minute quantities of SO_3 and F_2 put in the glass of necessity reduce RO_2, R_2O_3, and R_2O values in the glass. If it is desired to figure the batch raw materials for a six component system, then SO_3 and F_2 may be computed directly. This, however, is left up to the reader.

Of the two methods presented, determinants are easier to compute, but require more time and computation to use than matrices. Matrices, however, are by far easier to apply, for once the adjoint matrix has been computed, anyone can use it. A further fact in its favor is that the only time it needs to be re-computed is when a change of raw materials is enacted or more oxides are figured in the glass.

It is hoped that the reader will include his own short cuts in the application of this material, since space and time limitations have prohibited their inclusion here.

Acknowledgment

The author wishes to thank Ball Brothers Company, Inc., for permission to publish this article.

CONSOLIDATION OF THATCHER AND McKEE GLASS COMPANIES

The consolidation of Thatcher Glass Manufacturing Company, Inc., and McKee Glass Company was announced in a joint statement by Franklin B. Pollock, President of Thatcher, and A. K. Wood, President of McKee. Combined annual sales of the two companies are in the vicinity of $30,000,000.

The consolidation, which will be effective as soon as the necessary formalities are completed, will be accomplished through an exchange of all of the outstanding McKee stock for shares of Thatcher. It will involve no change in management or personnel of the McKee firm which will retain its corporate identity and be operated as a division of Thatcher. McKee officers will take an active part in the management and operation of the consolidated company.

Activities of the two companies are complementary. Thatcher is a leading producer of blown glass products and McKee is an important producer of pressed glass products. The world's largest maker of milk bottles which originally comprised its entire output, Thatcher now derives approximately three-quarters of its revenues from the sale of glass containers used in packaging foods, beverages (soft drinks, whiskies, etc.) and other products.

McKee Glass Company will, within two years, celebrate its centennial anniversary. Approximately two-thirds of its aggregate revenues normally are derived from the sale of industrial glass products. One of the most important recent additions to its industrial line is a large television lens employed in projecting images on theatre television screens. Another recent development is the company's special (#402) type x-ray glass from which a growing volume of business is expected.

PHILIP W. HATCH NAMED GENERAL MANAGER OF BALL BROTHERS DIVISION

Philip W. Hatch, commercial products Sales Manager for Ball Brothers Company and an associate of the firm for nearly 20 years, has been named General Manager of the company's Southwestern Division, with glass plant and headquarters in Okmulgee, Oklahoma.

The appointment, according to an announcement by Edmund F. Ball, President of the Muncie glass container firm, will become effective January 1, 1952. Mr. Hatch will continue to serve as Sales Manager for commercial products until that time. The announcement of Mr. Hatch's advancement coincided with the company's decision to establish its operations in the Southwest as a separate, autonomous division. Ball Brothers has owned and operated the Okmulgee properties since 1929. The move was a further step, Mr. Ball said, to strengthen and simplify the company's business through a decentralization of both products and operating divisions and to provide itself with a stronger operating group based upon broader organizational concepts.

In his new assignment, Mr. Hatch will serve as a member of the staff of the parent company's chief operating officer, Duncan C. Menzies, Executive Vice President and General Manager. Joining Ball in 1932 upon his graduation from Yale University, Mr. Hatch has been associated with the firm continuously with the exception of the five-year period during World War II when he was recalled to active duty as a Captain in the Air Corps Reserve. He returned to the company as an executive assistant in the zinc and rubber divisions. Later he was named assistant to the late Fred J. Petty, then Vice President and Director of commercial products sales. In 1949 Mr. Hatch was advanced to the managership of that sales division.

S. B. MEYER, GLENSHAW GLASS PRESIDENT, DIES SUDDENLY

Samuel B. Meyer, President of Glenshaw Glass Company, died suddenly in his home on October 2 at the age of 64.

Mr. Meyer, whose father was one of the founders of the firm, was also Treasurer, General Manager, and Sales Manager of Glenshaw Glass Company, as well as serving as Chairman of the Board.

Surviving are his widow, Mrs. Estella Seitz Meyer; two daughters, Jean O. and Grace K. Meyer, and a son, James E. Meyer.

HARBISON-WALKER EXPANSIONS

Harbison-Walker Refractories Company, through a wholly-owned subsidiary, is about to acquire the Warm Springs, California, plant of Laclede-Christy Company of Chicago. This will permit the company to enter immediately into a wider field in the production of basic refractories, and later of silica refractories. Up to this time, the Warm Springs plant has been devoted to the manufacture of tank blocks and other specialties for the glass industry.

Harbison-Walker has also organized a wholly-owned Brazilian subsidiary, named Harbison-Walker Minerios Ltda., which has acquired exclusive mining rights to large deposits of exceptionally pure magnesite in Brazil.

GLASS TANK FURNACES

(Translated from the French)

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INVENTIONS AND INVENTORS . . .

(*Continued from page* 566)

Two sheets of drawings. Assigned to General Electric Company by Henry J. Nolte.

The patent relates to the manufacture of miniature vacuum tubes particularly. After the parts have been assembled and molded, the bottom of the assembly is cooled so as to produce a compressive strain in the bottom from which the lead-in conductors 12 project. This assembly is then placed in a refractory fixture 30 and preheated after which the fixture, including a metal cylinder 34, is placed in an induction heating coil 40. While being heated, pressure is applied by the weight 42 and the leverage system shown on top of the exhaust tubulation 18′. Thus heat is applied to a definite area where the parts are sealed together and the most desirable strain produced in the parts.

The patent contains one claim and nine references were cited: 1,483,461, Littleton, Jr., Feb. 12, 1924; 2,048,556, McArthur, July 21, 1936; 2,125,316, Ronci, Aug. 2, 1938; 2,296,579, Seelen, Sept. 22, 1942; 2,318,652, Wiener, May 11, 1943; 2,359,501, White, Oct. 3, 1944; 2,386,820, Spencer, Oct. 16, 1945; 108,056 Australia, 1937; and 536,858, Great Britain, May 29, 1941.

Burn-off Method. Patent No. 2,570,899. Filed July 9, 1949. Issued Oct. 9, 1951. One sheet of drawings, none reproduced. Assigned to Union Carbide and Carbon Corporation by Raymond A. Wolf.

This inventor has discovered a method by which the size of the bead is controlled, or the bead virtually eliminated if desired, by directing against the softened glass of the moil, a blast of cooling fluid during the severing operation. It is essential that the blast of cooling fluid be applied against the softened glass of the moil—that is, on the moil side of the flame—in a localized region extending horizontally around the moil immediately adjacent the region where the severing flame is applied to the work piece, and that the flame and the cooling fluid and the stretching of the softened glass be continued simultaneously until severance of the moil occurs. Severance takes place between the flame and the cooling blast.

The patent contains five claims and the references cited were 1,674,366, Kadow et al., June 19, 1928; 1,719,588, Campbell et al., July 2, 1929; 2,215,980, Schreiber, Sept. 24, 1940; 2,322,336, Anderson, June 22, 1943; 2,334,111. McNamara et al., Nov. 9, 1943; and 85,234, Germany, 1896.

LACLEDE-CHRISTY MOVES EXECUTIVE OFFICES

Laclede-Christy Company has moved its main executive offices from Chicago, Illinois, to St. Louis, Missouri, according to an announcement by President J. Douglas Streett.

According to Mr. Streett's announcement, the move was decided upon after careful study of recently changed conditions due to defense demands and other important factors affecting operations. Further, the sales advantages which earlier prompted the firm's move to Chicago have been cancelled in shifts and reallocations resulting from the nation's plant decentralization and war program.

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CORHART APPOINTS RESEARCH DIRECTOR

The Corhart Refractories Company has announced the appointment of Dr. Wilson R. Barnes as Director of Research.

Dr. Barnes, formerly Associate Professor of Chemical Engineering at the University of Louisville and Director of its Institute of Industrial Research, succeeds Dr. Harold T. Smyth, now Research Consultant for the firm and Professor of Ceramic Engineering at Rutgers University.

Dr. Barnes is a graduate of Speed Scientific School, University of Louisville, where he received both Bachelor and Master degrees in Chemical Engineering. He received his doctorate in Chemical Engineering at Iowa State College.

ORGANIZATIONAL AND STAFF CHANGES AT BALL BROTHERS

Robert A. Campbell, former Vice President and General Manager of a tool manufacturing firm in Oklahoma, has joined Ball Brothers Company as a special assistant to Robert W. Biggs, Vice President and Manager of glass manufacturing in Muncie, Okmulgee, Oklahoma, and Hillsboro, Illinois.

Mr. Campbell resigned a vice presidency and the general managership of the Hinderliter Tool Company to become associated with Ball. Mr. Campbell will assist in all production matters relating to the operation of the company's two container plants in Muncie. He will be assigned duties embracing manufacturing administration and plant operation.

Creation of a new Consumer Products Sales Division and the appointment of William E. Palmer to direct the development of a broader range of consumer goods for Ball Brothers has also been announced.

The new sales executive will report to G. Fred Rieman, Vice President in Charge of Sales, at the company's home office as Manager of Marketing in charge of the new sales organization. The new division, Mr. Rieman said, will be responsible for the sale of Ball home canning supplies and for the development of consumer products that may be sold on a year-round basis.

Mr. Palmer recently resigned a five-year association with Benton & Bowles where he served as their Director of Merchandising. Prior to that, he was with Lever Brothers Company for 12 years in various capacities ranging from sales promotion work to that of divisional sales manager.

• The Westinghouse Electric Corporation will undertake a $296,000,000 expansion program extending beyond 1953, President Gwilym A. Price announced following a recent meeting of the Board of Directors.

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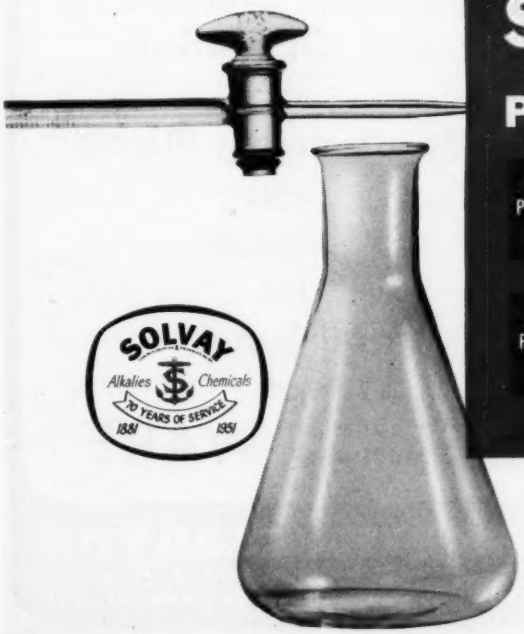

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TELEVISION TUBE MANUFACTURE . . .
(*Continued from page* 561)

annealing cycles by this method has been more completely discussed by H. K. Richardson in the *Bulletin of the American Ceramic Society* (Volume 29, Number 1, January 15, 1950).

Although its place in other heat processing has been well established, the use of radiant gas heating in television picture tube production is quite recent. Small individual radiant burners were the ones first applied, and these on machines for sealing in the guns. During a search for something more satisfactory than the bushy flames then applied directly to tube necks for preheating and annealing after sealing off, radiant burners were tried. These burners, heating without flame impingement, gave sufficiently improved performance that they have been adopted rather generally for such purposes.

Experiences with costly tube breakage, demands for floor space, and high equipment costs in other steps of the production processes served to focus attention on the advantages of radiant gas heat, and its successful application in the lamp industry confirmed a belief that it might improve television tube production also. Following this conviction, arrangements were made for laboratory studies on radiant heating of various sizes of tubes, with particular emphasis upon the baking of phosphor and conductive coatings. Extensive experiments were carried out on individual tubes to determine proper heat patterns, burner distances, effect of various wave lengths, differential tube temperatures, and the fastest safe baking cycles. Of particular significance was the discovery that heating time during which 16″ round tubes are raised to 400°C. could be safely reduced from ½ hour or longer to approximately twelve minutes.

After study of the information gained during the experimental program, a series of successful production installations have been made, and these have confirmed theoretical computations for shorter bake-out cycles. Reduction in baking time has in each case been accompanied by reduced shrinkage and appreciably lower energy cost, all in considerably less floor space.

In addition to radiant gas heated bake-out ovens, there are several production units utilizing radiant gas heat for tempering faces of glass-to-metal tubes, and here also there is a quality gain leading to further reduction of shrinkage. It is generally agreed by producers that radiant heat properly applied has the effect of causing much improved strain distribution across the tempered tube faces. The advantage of proper strain distribution, obviously, is to reduce the possibility of subsequent tube breakage.

Because of the value of the picture tube, each installation demands careful study before equipment is designed, and careful adjustment of radiant heat sources after installation to hold shrinkage factors to a minimum. In effect, gas radiant heating provides the tube manufacturer with a more flexible instrument than has been heretofore available to him. In this, radiant gas equipment may be compared to a photographer's high grade camera, whose greater versatility requires both more careful design and more careful adjustment.

In conclusion, it is significant to note that radiant gas heating can be effectively applied not only to secure faster heating but also faster cooling. This is accom-

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plished by employing radiant heat patterns which selectively retard the cooling of those sections where glass temperatures would be reduced too rapidly by the indiscriminate use of the forced air blast.

RESEARCH DIGEST

(*Continued from page* 567)

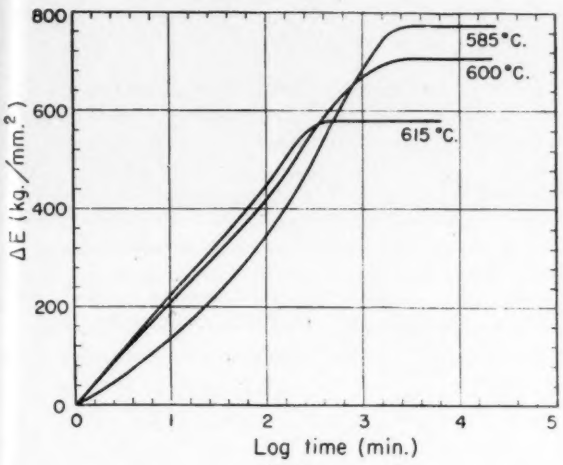

Fig. 2

2.55 mm., the index of refraction of a quenched sample was found lower by 2, 9, and 11 $\times$ 10^{-5}, respectively, than at 10.3 mm. In applying his work to annealing, Mr. Gillod proposes this analysis: Between 575° and 700°C. a barium crown glass undergoes a transformation expressed in variations of elasticity modulus, index of refraction, and expansion coefficient. The expansion curve indicates the approximate location, 575°C. This point can be located more closely by modulus determinations. A glass of infinitely small dimensions was obtained in homogeneous form by quenching from 630°C. after brief annealing. In a finite sample the interval from 630° to 575° introduces inhomogeneity, and in this interval much attention must be given to the schedule. Below 575° the schedule is irrelevant. Two temperatures of annealing will be selected, one about 30° below the softening range and one somewhat higher than the lower transformation limit, the closer the more refined index homogeneity is required. In this respect, work using the index of refraction quenching method originated by Winter has been carried out in more detail both in the U. S. and in France.

SOLVAY APPOINTS NEW MANAGERS

The appointment of new Sales and Branch Managers for several departments and district offices has been announced by the Solvay Sales Division, Allied Chemical & Dye Corporation.

Neal M. Draper, formerly Manager of the company's St. Louis branch, has been transferred to the New York executive offices as Manager of the Ammonium and Potassium Products Department. Harry R. Stoothoff, who has been Assistant Manager of the Chicago branch office, becomes Manager of the Special Alkalies & Cleansers Department. Verne W. Aubel, Jr. is advanced from supervisor to Manager of the Calcium Chloride Department.

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G. W. POLAND JOINS SERGEANT CHEMICAL COMPANY

Rudolph Aeberle, President of E. M. Sergeant Pulp and Chemical Company, has announced the election of George W. Poland, Jr., as a Vice President of the company and as President of its New Jersey subsidiary, Sergeant Chemical Company of Newark, New Jersey.

Mr. Poland recently resigned as Assistant Sales Manager of Stauffer Chemical Company, with whom he had been associated for 15 years. Previously, he had been with the American Agricultural Chemical Corporation.

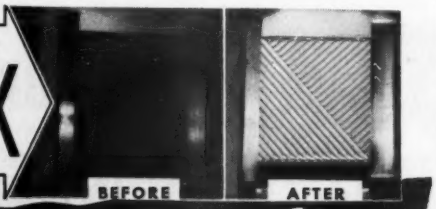
ACHESON COLLOIDS NAMES NEW MICHIGAN REPRESENTATIVE

Acheson Colloids Corporation has announced the appointment of Arthur T. Olsson as Sales Representative in Michigan. He will make his headquarters in Detroit at 3000 East Grand Boulevard.

Mr. Olsson came to Acheson from the Westinghouse Electric Corporation where he worked as an engineer in the Turbine Design Division at its South Philadelphia Works. He previously worked as a mechanical engineer for the Iron Mines Company of Venezuela, South America.

• Blaw-Knox Company's Chemical Plants Division has received a contract from American Window Glass Company for the engineering and construction of an autoclave and auxiliary equipment to be installed at Ellwood City, Pa., to increase the latter company's present facilities for producing safety glass.

Look



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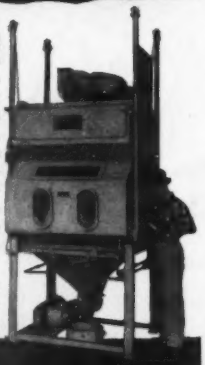

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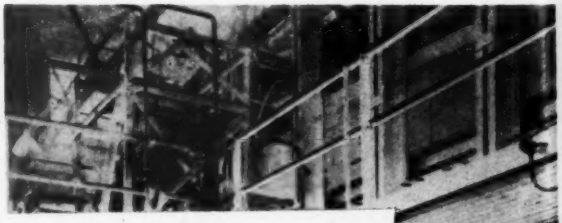

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LYNCH OPENS NEW WESTERN DIVISION OFFICES

Lynch Corporation has announced the opening of a new Western Division Office and Warehouse located at 221—11th Street, San Francisco, California. It will be managed by Cal B. Pierce, PAR Western District Manager. Art Nielsen, from the company's main plant in Anderson, Indiana, will serve as the new Sales Engineer.

The new location will be a sales office and warehouse for PAR air compressors. It will also handle west coast sales on Lynch glass forming machines and packaging machines, and other Lynch equipment.

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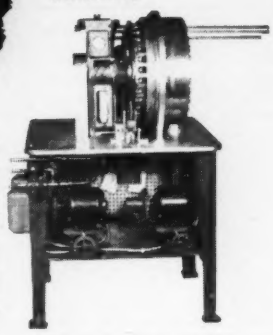

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NEW OFFICERS FOR G.A.M.A.

New officers of the Gas Appliance Manufacturers Association have taken office at a special meeting of the Board of Directors. They are Louis Ruthenburg, Chairman of the Board of Servel, Inc., who takes office as President. A. B. Ritzenthaler, Vice President of Tappan Stove Company, will move up to First Vice President, and J. F. Donnelly, Marketing Director of A. O. Smith Corporation, will become Second Vice President.

Lyle C. Harvey, President of Affiliated Gas Equipment, Inc., will retain his position as Treasurer, while H. Leigh Whitelaw will remain as Managing Director and Secretary.

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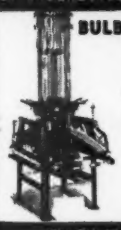

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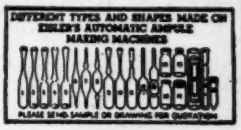

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